Evolution and Genetic Variability, Heritability and Genetic Advance of Hexaploidy Wheat (*Triticum Aestivum* L.) Genotypes under Irrigated Condition

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ABSTRACT

A field experiment was conducted in a randomized block design with three replications at the Agricultural Research farm, R.B.S. College, Bichpuri, Agra, (Uttar Pradesh) during 2018-19. Evaluated the protection potential of 27 genotypes namely K-1317, K-307, K-9423, DBW-39, K- 402, WH-147, DBW-17, K-1007, K-9107, HUW-234, K-7903, LOK-1, WH-711, Raj-3765, PBW-550, PBW-343, Raj-1482, Raj-4037, HUW-213, HD-3086, PBW-154, HD-2967, WH-1105,
PBW-502, PBW-373, PBW-226 and UP-2338 under irrigated with canal water condition. The observations were recorded on five randomly selected plants in each replication for each genotypesand the mean data for grain yield and its attributes. Initiation of spike, days to maturity, plant heightat maturity, number of tillers per plant, number of spikes per plant, number of spikelets per plant, spike length , number of grains per spike, weight of 1000-grains, grain yield per plant and grain yield per plot were subjected to an analysis of variance the results revealed that significant differences among 27 triticum aestivum genotypes for grain yield and its attributes among 27 triticum aestivum varieties WH-147 and K-7903 for grain yield. These genotypes may be process the for stresses as evidence by performance in predominantly soil and water use they should be included in direct cultivation in such environment as hybridization program to develop recombinants position high grain yield.

Introduction

Wheat (*Triticum aestivum* L.) is the world's leading cereal grain and most important food crop, occupying commanding position in Indian agriculture, which occupy 28% area under the cereal and contributing 33% of the total food grain production in the country. Wheat offer a great wealth of material for genetical studies due to its wide ecological distribution and enormous variation encountered for various morphological and physiological characters. (Rangare *et. al. 2009*).

In Indian wheat is mainly grown under the three production conditions *viz.* timely sown; medium to good fertility, irrigated; late sown, medium fertility; irrigated and timely sown; low fertility and in rained condition. (Datta *et. al., 2009)*

The ultimate aim of any plant breeding programme is to develop cultivars with high potential and consistent performance over diverse environments. Hybridization is an important source of creation of variation. The study of genetic variability is the pre-requisite for any crop improvement programme. Success in recombination breeding depends on suitable exploitation of genotypes as

parent of obtaining high heterotic crosses and transgressive sergeants or the presence of genetic variability in base population is essential. (Allarad, 1960)

The modern wheat breeding programmes focus on the improvement of agronomic and grain quality traits. The manipulation of wheat genetics has led to ever-increasing grain in yield and grains quality, while decreasing the ability of wheat to survive in the wild or in varying climate especially with the adverse conditions. In self pollinated crops the assessment of quantitative variable for genotypic variance, estimates of heritability and genetic advance of yield contributing characters are important for successful hybridization programme to evaluate new cultivars. (Amin *et. al.* 1992)

Selection on the basis of phenotypic variation is not efficient and selection therefore, based on evolution and utilization of genetic variability in a desired direction is extremely important in wheat improvement programme. The present study was is conducted in Upper Gangetic Plain withtimely sown wheat lines with objective to find out the extent of variability, heritability and genetic advance with environmental effect on timely sown advance lines developed at our center for elevenquantitative characters.

Materials and Methods

An experimental was conducted in completely randomized block design with three replications at The Agricultural Research Farm, R.B.S. College Bichpuri, Agra, (Uttar Pradesh) during 2018-19. The experimental material consisted Twenty-seven wheat genotypes . The sowing was done by hand dibbling method in rows with 25 cm spacing apart and 4cm within row on 2nd December 2018 (timely sown environment 2018-19).

The recommended economical practices and plant protection measures were followed for the successful raising of the crop.

Observation were recorded on the randomly selected five plants for grain yield and different yield contributing traits *viz.* Initiation of spike, days to maturity, plant height at maturity, number of tillers per plant, number of spikes per plant, number of spikelets per plant, spike length , numberof grains per spike, weight of 1000-grains, grain yield per plant and grain yield per plot. Their averages were used in the statistical analysis. The analysis of variance for R.B.D. was carried out by linear model suggested by Panse and Sukhatme (1985). The phenotypic and genotypic coefficient of variance which measure the magnitude of phenotypic and genotypic variationpresent in a particular character were computed by the formula given by Burton and De vane (1953).

The heritability in per cent in broad sense was estimated by Hanson, *et. al.* (1956) . Heritability values are characterized as low moderate and high by Robinson *et. al.* (1949).

The estimation of expected genetic advance from selection G(s), was obtained by the formula suggested by Robinson, Camstock and Harvey (1949) and genetic advance as percent of mean was classified as low, moderate and high by Johnson *et. al.* (1955).

Result and Discussion

Analysis of variation revealed that genotype genotypes were significant for all eleven characters *viz.* Initiation of spike, days to maturity, plant height at maturity, number of tillers per plant, number of spikes per plant, number of spikelets per plant, spike length , number of grains per spike, weight of 1000-grains, grain yield per plant and grain yield per plot. Present findings are similar with earlier report at Kumar *et. al.* (2014) and Saini and shewta (2017).

Table- 1. Mean Sum Squares Genotypes

Source of Variation	d.f.	Initiation of spike (in days)	Days to Maturity	Plant Height at Maturity (c.m.)	Number of Effective Tillers per Plant	Number of Spikes per Plant	Number of spikelets per Spike	Spike Length (c.m.)	Number of grains per spike	Weight of 1000-Grains (gm.)	Grain yield per plant (gm.)	Grain yield per plot (gm.)
Replication	2	0.11	0.01	19.67	0.78	0.79	0.90	0.47	3.20	0.04	1.08	402.26
Treatment	26	44.74**	8.50**	118.39**	7.69**	8.71**	5.01**	1.74**	15.84**	11.99**	28.01**	85010.43**
Error	52	0.47	0.61	7.12	1.20	1.06	0.98	0.39	2.31	0.27	1.28	8530.36
Total	80	14.85	3.16	43.60	3.30	3.54	2.29	0.83	6.73	4.07	9.96	33183.18
$SE_{(d)}$		0.56	0.64	2.18	0.90	0.84	0.81	0.51	1.24	0.43	0.92	75.41
C.D. at 5%		1.13	1.29	4.39	1.80	1.69	1.63	1.02	2.50	0.86	1.86	151.76
C.V. (%)		0.79	0.64	2.65	12.33	11.56	4.67	5.40	2.46	1.28	6.00	9.02

*, ** significant at 5% and 1% level, respectively

The phenotypic and genotypic coefficient of variability were computed to access the nature and magnitude to existing variability in the germplasm the present in Table ___

Indicates that the magnitude of PCV was variably higher than the GCV for all the traits under study. The highest magnitude of GCV was observed for number of Spikes for plant and numberof tillers per plant this indicate greater scope of obtaining high selection response for these traits owning the presence of high genetic variability. The existence of high variability. grain yield per plant in wheat is conformity with the finding of earlier workers. Bhushan *et. al. (*2013) Saini and Shewta (2017).

The moderate estimate of coefficient of variation at genotypic and phenotypic level were found for spike length, plant height at maturity, number of spikelets per spike, weight of 1000-grains, grain yield per plant and grain yield per plot. The six character exhibiting moderate PCV and GCVvalues as mentioned above, are likely to allow reasonable scope for improvement through selection due to the moderate genetic variability available in wheat genotypes evaluated. similar were finding Mecha *et. al.* (2016).

Low estimate of PCV and GCV parameters were observed for days to maturity, number of grains per

spike, initiation of spike, which suggested that selection directly based on these traits would not be much rewarding. The estimate of phenotypic coefficient of variation was slightly higher than the genotypic coefficient of variation for all the characters. similar were finding Deoraj *et. al.*(2000).

Genotypes	Mean	Range	Variance			Coefficient of Variance		[h^2 b)]% (	G.A.	G.A. as % mean
			σ^2g	σ2 p	σ^2e	G.C.V (%)	P.C.V (%)			
Initiation of spike (in days)	86.78	77.67 - 93.33	14.76	15.23	0.47	4.43	4.5	96.91	7.79	8.98
Days to Maturity	123.16	120.0 - 125.33	2.63	3.24	0.61	1.32	1.46	81.03	3.01	2.44
Plant Height at Maturity (c.m.)	100.89	90.83 - 117.62	37.09	44.21	7.12	6.04	6.59	83.88	11.49	11.39
Number of Effective Tillers/ Plant	8.89	7.00 - 13.00	2.16	3.36	1.2	16.55	20.64	64.31	2.43	27.34
Number of Spikes per Plant	8.9	7.00 - 13.00	2.55	3.61	1.06	17.94	21.35	70.66	2.77	31.07
Number of spikelets per Spike	21.16	19.00 - 24.00	1.34	2.32	0.98	5.48	7.2	57.87	1.82	8.59
Spike Length (c.m.)	11.51	10.16 - 14.10	0.45	0.84	0.39	5.84	7.96	53.94	1.02	8.84
Number of grains per spike	61.77	54.00 - 66.00	4.51	6.82	2.31	3.44	4.23	66.1	3.56	5.76
Weight of 1000-Grains (gm.)	40.81	36.56 - 45.46	3.91	4.18	0.27	4.84	5.01	93.52	3.94	9.65
Grain yield per plant (gm.)	18.82	13.09 - 25.77	8.91	10.19	1.28	15.86	16.96	87.48	5.75	30.56
Grain yield per plot (gm.)	1023.64	717.6 - 1372.7	25493.36	34023.72	8530.36	15.6	18.02	74.93	284.71	27.81

Table – 3. Genetic Variability

Heritability and Genetic Advance :-

The fundamental principle of plant breeding is the application of selection on the genetic variability available in germplasm for various character to change the genetic architecture of the plant character and consequently of the plant in order to develop improve genotypic genotypes possessing higher economic yield value than existing ones. Obviously, genetic material is the raw material on which the selection acts to bring improvement in genetic architecture of plants. Heritability in broad sense and genetic advance in as percent of mean as direct selection parameterprovides in the transmissibility of traits which give indication about the effectiveness of selection in improving the characters.

The higher estimates of heritability in broad sense was found for initiation of spike followed by weight of 1000-grains, grain yield per plant, plant height, days to maturity, grain yield per plot while low estimates of the heritability was found for spike length followed by number of spikelets per spike, number of tillers per plant and number of grains per spike similar were finding Mohsin *et. al.* (2009) and Khokhar *et. al.* (2010).

The highest genetic advance has been recorded for grain yield per plot followed by plant height,

initiation of spike, grain yield per plant, weight of 1000-grains, while lowest genetic advance has been recorded for spike length followed by number of spikelets per spike, number of tillers per plant, number of spikes per plant and days to maturity. similar were finding Khokhar *et. al.* (2010) and Kumar *et. al.*(2017).

Conclusion

The results showed that significant variation existing among 27 wheat genotypes. WH-147 showed high mean performance for grain yield per plot(1372.70gm).High heritability along with high genetic advance was observed for initiation of spike, weight of 1000-grains, grain yield per plant and plant height at maturity. Genotype WH-147(1372.70gm), K-7903(1364.90gm), PBW-343(1303.50gm), LOK-1(1268.37gm), PBW-226(1160.23gm) attributed high grain yield per plot and should be material selected as high yielding genotypes for future experimentation to obtain a better yielding varieties under Agra Uttar Pradesh condition.

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Impact of weed management and nitrogen use on weed flora and yield of Direct-Seeded Rice(DSR) in Southern part of Punjab

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ABSTRACT

An experiment was conducted to find the appropriate weed management and Nitrogen use for DSR (direct-seeded rice) in the southern part of Punjab during 2018 and 2019. The result indicated that pendimethalin + bispyribac and oxadiargyl + bispyribac application reduced the density and biomass of narrow-leaved weeds (NLW) and broad-leaved weeds (BLW) followed by oxadiargyl + fenoxaprop in both years. Application of pendimethalin + bispyribac decreased the total weed biomass by (84 and 100%, respectively) compared to unweeded control (80.1 and 94.8 m^2) in 2018 and 2019. Likewise, herbicides application increased the grain yield of DSR by 72.0 and 48.6% in 2018 and 2019, respectively, over unweeded control (2.79 and 3.50 t/ha). Pendimethalin + bispyribac and oxadiargyl + bispyribac application recorded a higher yield of grain and biological followed by oxadiargyl + fenoxaprop. Weedy check recorded the highest grain yield (5.20 and 5.40 t/ha) and net returns (55.8 and 58.4 $X10^3$ rs/ha, respectively, in 2018 and 2019) in DSR. Nitrogen application at 120 and 150 kg/ha recorded the lowest density and biomass of NLW, BLW and total weeds. Nitrogen application at 120 and 150 kg/ha enhanced the grain yield (4.89 and 5.25 t/ha) and net returns (55.1 and 60.5 $X10^3$ rs/ha) in both years. No nitrogen application recorded the lowest grain yield and highest density and biomassof weeds. Based on the findings, it may be concluded that pendimethalin + bispyribac and oxadiargyl + bispyribac with N 120 kg/ha application can reduce the intensity of weeds with higher grain yield in direct-seeded rice in Punjab.

Keywords*:* Bispyribec-Na, Direct–Seeded Rice, Nitrogen levels, Weed dynamics

INTRODUCTION

Direct–seeded rice (DSR) has been promoted as an option to intensive puddled- transplanted rice in Punjab. In DSR, weed composition is diverse in comparison to puddled rice and therefore yield reductions are quite common (Singh et al., 2016). Findings reported that yield reduction up to 35-60% could occur in DSR without suitable weed control practices (Rao and Ladha 2013; Sepat et al., 2015). Therefore, in DSR, weed management is an important aspect to achieve higher productivity than transplanted rice. Weed control through chemicals can be a suitable option compared to hand weeding. However, single herbicide use cannot

provide adequate weed control in DSR due to floristically diverse weed communities (Brar and Bhullar 2012). Meanwhile, it can also lead to weed flora shifts and the evolution of herbicide resistance over the years (Gosh et al., 2016). In rice, continuous use of bispyribac-sodium to control Echinochloa crusgalli (L.) P. Beauv shifted weed flora toward *Leptochloa chinensis* (L.) Nees (Marambe, 2002) in Delhi. Several findings show that narrow-leaved weeds are poorly controlled by bispyribac-sodium (Farooq et al., 2011). The sequential application of pendimethalin and bispyribacsodium effectively controlled *Echinochloa* spp., while the control of *Eragrostis* spp. and

L. *chinensis* was poor (Brar and Bhullar, 2012). In DSR, herbicides used so far have a narrow weed control spectrum. Therefore efficacy and compatibility of tank mixtures of different herbicides for diverse weed flora need to be evaluated in DSR.

In DSR, N optimization is essential for higher grain yield (Kumawat et al., 2017). Several findings (Zhang et al., 2009) reported that anaerobic soil conditions in DSR demand higher N side as the N losses are high. In Punjab, to achieve higher grain yield in DSR, many researchers reported that 150-180 kg N/ha is required (Singh et al., 2007; Thind et al., 2018). However, weed infestation can influence the N demand in DSR (Hitesh et al., 2018). In DSR, minimal studies have been done on the interaction between weed and nitrogen. Therefore, an experiment was conducted to study the impact of various weed options and nitrogen levels on weed dynamics, productivity and profitability of direct-seeded rice at KVK Ferozpur during 2018 and 2019.

MATERIALS AND METHODS

An experiment was conducted during the summer (*kharif*) seasons of 2018 and 2019 at Krishi Vigyan Kendra (KVK) at Ferozepur (30˚54'33 N, 74˚39'50 E, 243 MSL) in Punjab. The climate of the experimental site is sub-tropical, semi-arid, with hot, dry summers and cold winters. The mean annual rainfall is 484 mm and 85% falls during the rice-growing season (June–October). The total rainfall received during experimentation was 732 and 446 mm in 2018 and 2019, respectively. The mean maximum and minimum temperatures were 39 and 19 °C, respectively. The soil of the experimental field was a sandy clay loam up to 30 cm soil depth and is classified as an Inceptisol (Typic Haplustept). The soil pH was 8.0 and electrical conductivity was 0.45 dS/m in 0-15 cm depth. The soil has an organic carbon content of 0.62%, permanganate extractable N of 152 kg/ha, $NaHCO_3$ extractable P of 11.0 kg/ha and NH_4OAc-extractable K of 135 kg/ha. The site had grown puddled transplanted rice-wheat cropping system for the previous 10 years. The experiment was laid in a split-plot design with three replications. In main plot, three weed management practices such as pendimethalin (0.75 kg ai/ha) as pre- emergence (PRE), followed by (fb) bispyribac-sodium (0.025 kg ai/ha) as post-emergence (POST), oxadiargyl (0.09 kg ai/ha) PRE fb bispyribac-sodium (0.025 kg ai/ha) POST and oxadiargyl (0.09 kg ai/ha) as PRE fb fenoxaprop-p-ethyl with a safener (0.07 kg ai/ha) POST along with weedy check and unweeded control while N levels viz., 0, 100, 120 and 150 kg N/ha were taken in subplots. The herbicides were applied using a knapsack sprayer that delivered around 500 L/ha spray solution for PRE and 375 L/ha for POST herbicides through a flat fan nozzle. The crop cultivar "PR 114" was taken in both the years. N levels were applied as per treatments while P (60 kg P_2O_5/ha) and K (40 kg K_2O/ha) were applied based on the recommended dose in Punjab. For weed sampling, two quadrats of 40 cm X 40 cm were randomly located in each plot at 45 DAS to determine the density and biomass of narrow leaved and broad-leaved weeds. Weed biomass was recorded after drying the weed samples at 70□C in an oven for 48 h.

Harvesting was done manually in October and grain yield as per plot (15 m^2) was recorded at moisture content of 14.0%. Weed density and biomass data were square-root-transformed before performing ANOVA because of high variance. Treatment means separation was done by using Fishers LSD at 5% significance level when *F* tests indicated that significant differences existed ($p < 0.05$) (Payne RW 2009).

RESULTS AND DISCUSSION

Weed density and biomass

In DSR, *Echinochloa crusgalli* (L.) P. Beauv., *Echinochloa colona* (L.) Link., *Leptochloa chinensis and Dactyloctenium aegyptium* (L.) Wild. were the major narrow-leaved weed (NLW) while *Digitaria sanguinalis* (L.) Scop., *Eleusine indica* (L.) Gaertn were the broad-leaved weeds (BLW) observed during 2018 and 2019. In general, NLW density was higher in 2019 over 2018 (Table 3). However, the density and biomass of BLW remained static in both years. Unweeded control recorded higher density and biomass of NLW, BLW and total in 2018 and 2019. Pendimethalin + bispyribec and oxadiargyl + bispyribac recorded lower density and biomass of NLW, BLW and total weed followed by oxadiargyl + fenoxaprop in 2018 and 2019. The treatments viz., pendimethalin + bispyribec (7.5 and 8.9 no/m^2) and oxadiargyl + bispyribac (7.5 and 12.5 no/m^2) recorded lowest density of weeds which remained at par with weedy check. Pendimethalin + bispyribec and oxadiargyl + bispyribac reduced the density of total weeds by 177.3 and 189.9% compared to unweeded control (20.8 and 25.8 no/m^2 in 2018 and 2019, respectively). Pendimethalin + bispyribec controlled the wide range of weeds flora including NLW and BLW, and therefore reduction in total weed density and biomass was recorded in DSR (Jabran et al., 2012). A reduction in NLW density was observed with oxadiargyl + fenoxaprop application, but E. crusgalli remained high. Likewise, D. aegyptium density recorded high in oxadiargyl + bispyribac treatment (Brar and Bhullar 2012).

In 2018 and 2019, N application influenced the density and biomass of NLW, BLW and total (Table 3). No N application recorded the highest density and biomass of NLW, BLW and total weed in both years. N at 120 and 150 kg/ha application recorded the low density and biomass of NLW and BLW compared to N 100 kg/ha. N 120 kg/ha reduced the density of total weeds by 29.30 and 39.10% compared to no N application (72.7 and 73.6 in 2018 and 2019, respectively). The optimum N application hampered the weed growth (Hitesh et al., 2018), which promoted the growth and yield attributes of rice crops.

Yield attributes

In 2018 and 2019, weed practices significantly influenced the yield attributes such as no. of effective tillers/m2 and no. of filled grains/panicle except panicle weight and test weight in DSR (Table 1). Pendimethalin + bispyribac and oxadiargyl + bispyribac recorded at par no. of effective tillers/m^2 and no. of filled grains/panicle. Pendimethalin + bispyribac application increased the effective tillers/m2 (35.3 and 22.5%) and no. of filled grains/panicle (33.0 and 33.3%) over unweeded control (207 and 245 in 2018; 108, respectively; and 100 and 108 in 2018 and 2019, respectively). The low occurrence of weeds in treated plots enhanced the yield attributes as rice crops faced low competition for space and nutrients (Singh et al., 2016). No. of effective tillers/m^2 and no. of filled grains/panicle were recorded highest in weedy check and remained lowest in unweeded control in 2018 and 2019.

N levels enhanced the no. of effective tillers/m2 (33.3 and 34.3) and no. of filled grains/panicle (56.0 and 34.3%) compared to no N application (213 and 230 in 2018 and 2019, respectively;
91 and 108 in 2018 and 2019, respectively) in DSR (Table 1). Application of N at 120 and 150 kg/ha recorded at par values of no of effective tillers/m2 and no. of effective grains/panicle compared to N 100. High infestation of weeds with no N application and N at 100 kg/ha reduced the growth and vigour of rice crop, and thereby reduction in effective tillers/plant was noticed (Singh et al., 2007).

Yield

Grain and biological yield significantly influenced weed practices during 2018 and 2019 (Table 2). In 2018 and 2019, weedy check recorded the highest grain (5.2 and 5.4 t/ha in 2018 and 2019) and biological yield (11.4 and 11.9 t/ha in 2018 and 2019) in DSR. The weed-free environment in the weedy check increased rice crop nutrient uptake, which enhanced the grain yield (Rao et al., 2013). Pendimethalin + bispyribac and oxadiargyl + bispyribac were recorded at par grain and biological yield values during both years, followed by oxadiargyl + fenoxaprop. In 2018 and 2019, unweeded control recorded the lowest grain (2.79 and 3.50 t/ha in 2018 and 2019) and biological yield (6.1 and 7.1 t/ha in 2018 and 2019) in DSR. The sequential application of pendimethalin and bispyribac effectively controlled Echinochloa sp. and D. *sanguinalis* while the control of Eragrostis sp. and L. *chinensis* was poor (Brar and Bhullar, 2012). Recently, Singh et al. (2015) reported similar findings with pendimethalin followed by (fb) bispyribac-sodium compared with the weed-free check-in rice.

N application significantly affected the grain and biological yield in 2018 and 2019 (Table 2). No N application gave the lowest yield of grain (3.20 and 3.92 in 2018 and 2019) and biological (7.0 and

8.6 t/ha in 2018 and 2019) in DSR. N 120 and 150 kg/ha were recorded at par valuesof grain and biological yield in DSR. N at 120 kg/ha increased the rice grain yield by 52.8 and 33.9% compared to no N application (3.2 and 3.9 t/ha in 2018 and 2019, respectively). A high correlation (r2=0.99) was found with nitrogen application between total weed density and grain yield in both years (Fig. 1). Grain yield reduced by 0.54 kg/ha in 2018 and 0.89 kg/ha in 2019 with the increase of 10 m^2/ha total weed density. N application enhanced the celldivision, and thereby growth and vigour of rice crop (Kumawat et al., 2017).

Economics

Application of herbicides significantly influenced the cost of cultivation and net returns in 2018 and 2019 (Table 3). Higher cost and use of labour escalated the cost of cultivation in weedy check (35.2 and 37.2 $X10^3$ rs/ha in 2018 and 2019). However, herbicide application in pendimethalin + bispyribac and oxadiargyl + bispyribac reduced the cost of cultivation in both years. Unweeded conmtrol recorded the lowest cost of cultivation (27.0 and 29.0 $X10^3$ rs/ha in 2018 and 2019) as no weed control practice was done for weed control. In unweeded control, high infestation of weeds (Gosh et al., 216) reduced the grain yield, and thereby net returns in 2018 and 2019. Pendimethalin + bispyribac and oxadiargyl + bispyribac recorded higher net returns followed by oxadiargyl + fenoxaprop and unweeded control. In herbicides treated plots, higher yield produced with low cost of product enhanced the net returns compared to unweeded control where high labour wages (Farooq et al., 2011) significantly reduced the net returns in 2018 and 2019. The different levels of N significantly influenced the cost of cultivation and net returns compared to no N application in 2018 and 2019 in DSR (Table 3). N at 120 and 150 kg/ha increased the grain yield, and therefore higher net returns (Kumawat et al., 2017) compared to no n application. Based on the findings, it may be concluded that pendimethalin at 0.75 kg/ha or oxadiargyl at 0.09 kg application as pre-emergence followed bybispyribac at 0.025 kg/ha as post-emergence with nitrogen at 120 kg/ha can reduce the weed intensity with higher grain yield in direct–seeded rice.

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Table 1: Effect of weed and nitrogen management on weed density and weed biomass in direct-seeded rice during 2018 and 2019

ment	Weed density (no/m^2)						Weed biomass (g/m^2)					
	Broad-leaved		Narrow-leaved		Total		Broad-leaved		Narrow-leaved		Total	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
Weed practices												
Pendimethalin + bispyribac	3.1	2.8	4.4	6.1	7.5	8.9	19.3	12.8	24.2	34.5	43.5	47.3
Oxadiargyl + bispyribac	3.2	4.7	4.3	7.8	7.5	12.5	22.8	18.2	25.5	35.3	48.3	53.5
Oxadiargyl + fenoxaprop	5.1	4.0	6.1	7.9	11.2	11.9	29.0	20.7	28.8	38.7	57.8	59.4
Weedy check	0	0	0	0	0	0	0	0	0	0	0	0
Unweeded control	8.9	10.2	11.9	15.6	20.8	25.8	31.1	30.9	48.0	63.9	80.1	94.8
SEm+	0.62	0.56	0.52	0.35	0.80	0.76	0.60	0.67	1.02	0.92	0.94	0.98
LSD (P=0.05)	1.92	1.78	1.64	1.83	2.52	2.39	1.89	2.11	3.20	2.89	2.99	3.11
N levels												
N0	6.2	8.5	8.8	14.7	15.0	23.2	31.9	28.7	40.8	44.9	72.7	73.6
N100	4.4	4.3	6.2	6.9	10.6	11.2	17.3	11.3	22.2	34.3	39.5	45.6
N 120	2.0	2.0	2.2	4.0	4.2	6.0	13.2	12.4	18.4	28.5	31.6	40.9
N 150	3.8	2.5	4.0	4.4	7.8	6.9	19.4	13.7	20.6	30.2	40.0	43.9
SEm+	0.38	0.42	0.40	0.44	0.58	0.56	0.45	0.53	0.68	0.63	0.58	0.88
LSD (p=0.05)	1.20	1.32	1.28	1.40	1.82	1.76	1.43	1.68	2.16	1.99	1.87	2.80

Table 2: Effect of weed and nitrogen management on yield attributes in direct-seeded rice during 2018 and 2019

Treatment	No of effective tillers/m^2		No of filled grains/panicle		Panicle weight/plant (g)		Test weight (g)	
	2018	2019	2018	2019	2018	2019	2018	2019
Weed practices								
Pendimethalin fb bispyribac	280	300	130	144	1.75	2.00	22.8	23.9
Oxadiargyl fb bispyribec	280	292	128	143	1.59	1.90	21.9	23.0
Oxadiargyl fb fenoxaprop	272	278	120	128	1.55	1.84	21.1	22.5
Weedy check	295	305	141	147	1.89	2.00	21.4	23.0
Unweeded control	207	245	100	108	1.42	1.42	20.2	22.0
SEm+	7.30	7.72	4.06	4.73	0.03	0.02	0.38	0.42
LSD (P=0.05)	22.9	24.2	12.7	14.8	0.09	0.07	NS	NS
N levels								
N0	213	230	91	108	1.25	1.50	18.6	21.0
N100	264	289	122	139	1.72	1.85	21.8	22.5
N 120	284	309	142	145	1.78	1.95	23.1	24.0
N 150	306	308	140	144	1.80	2.00	24.8	24.0
SEm+	5.94	6.13	3.04	3.57	0.01	0.01	0.35	0.38
LSD (p=0.05)	18.70	19.2	9.5	11.2	0.03	0.02	1.10	1.19

Table 3: Effect of weed and nitrogen management on yield and economics of direct –seeded rice during 2018 and 2019

Treatment	Yield (t/ha)				Cost of cultivation ($X10^3$ rs/ha)		Net returns ($X10^3$ rs/ha)	
	Grain		Biological					
	2018	2019	2018	2019	2018	2019	2018	2019
Weed practices								
Pendimethalin fb bispyribac	4.80	5.20	10.6	11.4	30.0	32.0	54.0	60.0
Oxadiargyl fb bispyribec	4.78	5.11	10.5	11.2	30.0	32.0	53.7	58.5
Oxadiargyl fb fenoxaprop	3.78	4.89	8.3	10.8	28.5	30.5	37.7	56.1
Weedy check	5.20	5.40	11.4	11.9	35.2	37.2	55.8	58.4
Unweeded control	2.79	3.50	6.1	7.7	27.0	29.0	21.8	33.0
SEm+	0.03	0.04	0.07	0.06	-	-	1.54	1.76
LSD (P=0.05)	0.09	0.12	0.21	0.19	-	-	4.82	5.50
N levels								
N0	3.20	3.92	7.0	8.6	29.0	31.0	27.0	38.4
N100	4.20	5.00	9.2	11.0	30.2	32.2	43.3	56.3
N 120	4.89	5.25	10.8	11.6	30.4	32.4	55.1	60.5
N 150	4.80	5.10	10.6	11.2	30.9	32.9	53.1	57.4
SEm+	0.02	0.03	0.06	0.03	-	-	0.72	0.79
LSD (p=0.05)	0.06	0.09	0.18	0.11	-	-	2.27	2.49

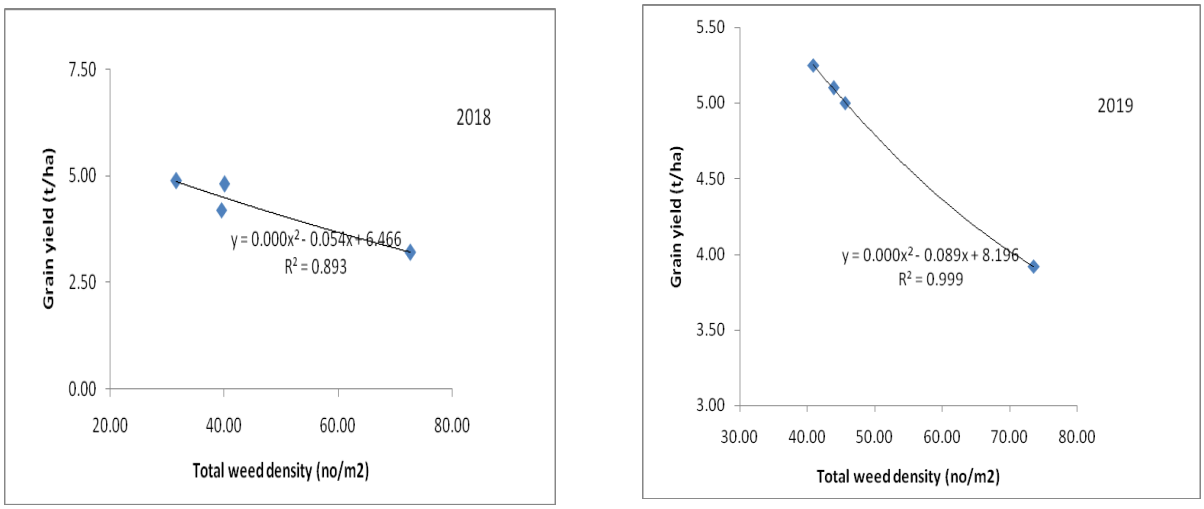

Fig 1: Relationship between total weed density and grain yield of rice during 2018 and 2019

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STUDY OF WASTE WATER GENERATED FROM STEEL INDUSTRIES ANDTEXTILE INDUSTRIES

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ABSTRACT

The research is carried out to study the quality of water generating from various industries present in Mandi Gobindgarh in Punjab as Mandi Gobindgarh is also known as "Loha Mandi" because in this district large number of steel factories is located and waste water effluent of Steel industries contains large number of various heavy metals and the study also includes the study of physio-chemical properties of waste water generated from textile industries specifically located in Ludhiana district of Punjab state as Ludhiana's is the largest hub for hosiery manufacturing. The rapidly growing population, urbanization, and industrialization are putting more stress on water resources and in the repercussion of this the quality of water deteriorating day by day due to tremendous industrialization or due to anthropogenic activity. The availability of fresh water for drinking and sanitation services becoming a problem for municipal from both rural to the urbanization.

Keywords: Heavy metals, Waste water, Waste water treatment

INTRODUCTION

In many developing countries the bulk of domestic and industrial wastewater is discharged without any treatment or after primary treatment only (Jayashree Dhote , Sangita Ingoleb and Arvind Chavhan, 2012).From various sources like as in residential areas, commercial areas, industrial properties, agriculture lands etc the waste water is generated. Wastewater contains inorganic substances like solutes, heavy metals, and metal ions, ammonia along with gases, complex organic compounds such as excreta, plant material, food, protein, natural organic matter, nitrate and other pollutants present in surface water, ground water and/or industrial water (Ibraheem et al., 2012). Domestic waste water may be treated in centralized plants, pit latrines, septic systems or disposed of in unmanaged lagoons or waterways, via open or closed sewers (UNEP, 1993). In some cases industrial wastewater is discharged directly into water bodies, while major industrial facilities may have comprehensive in plant treatment (Carter et al., 1999;

Doorn et al., 2006).

In developed nations, treatment and discharge systems can sharply differ between countries and between rural and urban users, with respect to urban high income and urban low-income users (*Doorn et al., 2006*). The most common wastewater treatment methods in developed countries are centralized aerobic wastewater treatment plants and lagoons for both domestic and industrial wastewater (Duncan Mara; 2013).In fact as far as India is concerned polluted water is one of the major factors behind the general low levels of health in India, especially in the rural areas. Polluted water can lead to diseases such as cholera, tuberculosis, dysentery, jaundice, diarrhoea, etc. In fact, around 80% stomach ailments in India happen because of consuming polluted water (*Samudranil, 2016).* This research includes the study of physio-chemical properties of waste water generated from steel manufacturing industries located in MandiGobindgarh district it is also known as "LohaMandi" because in this district large number of steel factories is located and waste water effluent of Steel industries contains large number of various Heavy Metals and study also includes the analysis of waste water generated from textile industries located in Ludhiana District because large number of textile industries located in Ludhiana.

Major pollutants in textile wastewaters are high suspended solids, chemical oxygen demand, heat, colour, acidity, and other soluble substance. Environmental problemsof the textile industry are mainly caused by discharges of wastewater (D.A Yaseen& M. Scholz, 2018). Textile industries aremajor sources of these effluents due to the nature of theiroperations which requires high volume of water that eventually results in high wastewatergeneration. Textile effluents are high in BOD due to fiber residues and suspended solids(AEPA, 1998). They can contaminate water with oils, grease, and waxes while some maycontain heavy metals such as chromium, copper, zinc and mercury (EPA 1974**).**

Ground Water Scenario of Mandi Gobindgarh

Water bearing formations in the area mainly include fine to medium grained sand or sand with little admixture of clay. At shallow depth the ground water occurs under unconfined water table conditions and in deeper aquifers occurs under confined conditions. The depth to ground water table in the area ranges from 4.05 m below ground level (mbgl) in the central to 18.10 mbgl in the north eastern parts.

The quality of ground water in shallow aquifers confirm to maximum permissible limits for

drinking water standards except along western part where high values of fluoride (1.5 to 2.10 ppm) have been noticed and in central Fatehgarh Sahib showing high values of sodium, zinc, iron, sulphate, nitrate and chloride.

The deeper waters in general are found to be suitable for irrigation and domestic purposes.

Ground Water Scenario of Ludhiana

As per Central Ground Water Board, Ludhiana states that the shallow ground water is getting polluting by heavy metals like copper, lead, manganese and iron. However, in deeper aquifer the concentration of these heavy metals is low as compare to shallow aquifer. The overall review of trace elements analysis indicates that the presence of heavy metals in the ground water at shallow and deeper aquifers, which is due to industrial pollution.

As per Brief Industrial Profile of Fatehgarh Sahib stated that MandiGobindgarh, the Steel Town which was blessed by the sixth Guru of Sikhs Shri Guru Hargobind Sahib as "Steel City" also falls in this district. Today this small city produces 25 percent of the total steel productions of India. So, Industrial effluent also becoming the major concern for sustainable development.

MATERIALS AND METHODS

Samples of wastewater from two steel industries and three textile industries from Ludhiana have been taken and demonstrated the physio-chemical properties and types of heavy metals also demonstrated. Samples were collected in good quality screw capped high density pre sterilized polypropylene bottles, each of 1lt capacity, labeled properly and analyzed in laboratory. Water samples consisting of industrial effluents were collected in sterile sampling bottles. For industrial effluents, samples were collected at the discharge points of each industry. These included: Sample 1 (steel industry), Sample 2 (steel industry), Sample3 (textile industry) Sample4textile industry) and Sample 5 (textile industry).

Determination of phsico-chemical parameters:

During sampling, water samples were analysed on site for Ph by using test method of APHA-4500, 23rd edition 2017, Total Dissolved Solids (TDS) by using test method of APHA-2540C, 23rd edition 2017.

Determination of Heavy Metal Analysis:

This experiment was conducted to assess the levels of some heavy metals, Pb, Cd, Cu, Zn were determined in water samples collected from (Steel Plant) an industrial area and textile industry.

Samples were collected in good quality screw capped high density pre sterilized polypropylene bottles, each of 1lt capacity, labelled properly and analyzed in the NaBL approved laboratory.The selected heavy metals (lead, Zinc, Cadmium, and Chromium,) were analysed by Atomic Adsorption Spectrophotometry (AAS). Along with heavy metal analysis some other parameters were also analysed.

S.NO	SAMPLE
SAMPLE 1	Effluent from Steel Industry1
SAMPLE 2	Effluent from Steel Industry 2
SAMPLE 3	Effluent from Textile Industry
SAMPLE 4	Effluent from Textile Industry
SAMPLE 5	Effluent from Textile Industry

Table 1:- Waste water Samples

Atomic Absorption Spectrometry (AAS) is a very common and reliable technique for detecting metals and metalloids in environmental samples. In order to measure the concentration of heavy metals in water and mud samples, a typical set of standard calibration curves with good linear regression and better relative standard deviations were achieved. Atomic Absorption Spectroscopy (AAS) is the preferred analytical technique due to the following reasons:

FIG1: WASTE WATER SAMPLE COLLECTION

RESULTS AND DISCUSSIONS

Results of phsico-chemical characteristics of all 5 wastewater samples and analysis of quantity of

heavy metals in waste water is tabulated below:-

Table 1: Chemical analysis and pH value of wastewater collected from different industries.

Parameters	**pH**	**TDS**	**Concentration (ppm)**			
Samples			**Pb**	**Zn**	**Cd**	**Cr**
Sample 1 (Steel Industry)	6.82	870	0.6	4.9	ND*	1.8
Sample 2 (Steel Industry)	7.24	858	0.4	3.2	ND*	1.4
Sample 3 (Textile Industry)	4.3	25600	0.04	0.07	0.16	0.9
Sample 4 (Textile Industry)	8.1	30000	3.6	2.8	0.25	1.34
Sample 5 (Textile Industry)	8.2	16000	4.31	0.4	0.14	1.5

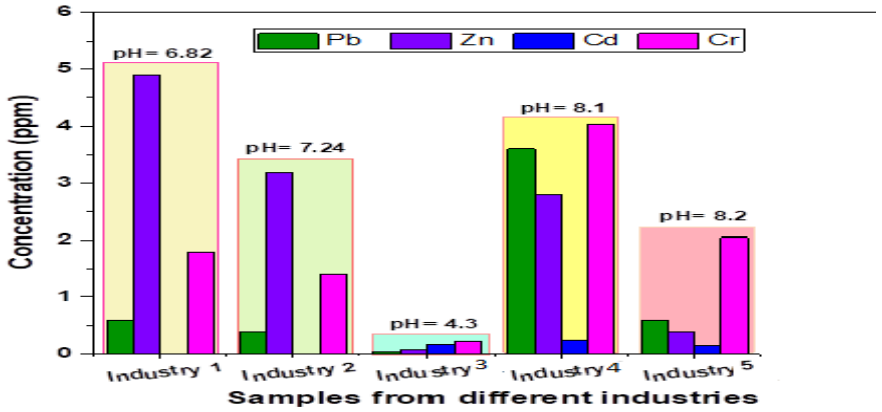

Fig.4.2: Concentration of heavy metals and pH of the different samples.

The selected heavy metals (Lead, Zinc, Cadmium, and Chromium,) were analyzed by Flame Atomic Absorption spectroscopy.

While survey of the industries it has been observed that being a developing country industrialization growth is important in many ways as it provide employment to many people and that too help in increasing livelihood of the people. It is important for creating employment opportunities, promotion of education, training and research.

It is also observed that present treatment methods for final disposal of effluent are very costly not suitable for medium scale industries. Most conventionaltechniques like as extraction, sedimentation, trickling filterationand chemical oxidation are generally effective but they often

prove to be very expensive. The capability to decrease toxic substances to safe levels effectively and at a reasonable cost is consequently very important (A.J. Englande, Peter Krenkel and J. Shamas, 2015).

Accumulating evidences constantly indicate that the transition of the existing industries into eco-industrial network through successful implementation of green approaches provides a viable solution to preserve the natural resources of the region while concurrently enhances the regional economy on a sustainable basis. It calls for an appropriate planning and integrated framework in harmony with the environment, after careful assessment of past and prevailing conditions.

It has been observed that the textile industry uses high volume of water throughout its operation, from the washing of fibers to bleaching, mercerizing, dyeing, printing and washing of finished products.

The present research work deals with the study of four heavy metals (Cd, Zn, Pb, and Cr). The analysis is performed using AAS. Results indicated that the range of concentration of Cd found in wastewater of textile industry i.efrom 0.14-0.25 mg/l and not detectable in other steel industries.

The concentration of Pb (lead) is found from 0.4-4.31 mg/L has been observed and maximum concentration was found in textile industry. Results indicated that the range of concentration ofChromium was found from 0.9-1.8mg/l and maximum concentration of chromium was found in steel industry.

The study has shown that almost all the heavy metals are at higher levels or near to the higher level than the prescribed limits as mentioned in table no 3. Especially waste water of textile industry has higher level of all heavy metals. Hence proper treatment methods are needed for waste water treatment before final disposal or to within prescribed limit.

Table 2: general physical standards for drinking water prescribed by BIS (IS 10500:2012)

S. No.	Parameter	Inland surface water	Public sewers	Land for irrigation
.	2		3	.
	.	(a)	(b)	(c)
1	Colour and odour	See 6 of Annexure-1I		See 6 of Annexure-1I
2	Suspended solids mg/l, max.	100	600	200
3	Particle size of suspended solids	shall pass 850 micron IS Sieve	-	-
4	pH value	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0

5	Temperature	shall not exceed $5^{o}C$ above the receiving water temperature		
6	Oil and grease, mg/l max,	10	20	10
7	Total residual chlorine, mg/l max	1.0	-	-
8	Ammonical nitrogen (as N),mg/l, max.	50	50	-
9	Total kjeldahl nitrogen (as N);mg/l, max. mg/l, max.	100	-	-
10	Free ammonia (as NH3), mg/l,max.	5.0	-	-
11	Biochemical oxygen demand (3 days at $27^{o}C$), mg/l, max.	30	350	100
12	Chemical oxygen demand, mg/l, max.	250	-	-
13	Arsenic(as As).	0.2	0.2	0.2
14	Mercury (As Hg), mg/l, max.	0.01	0.01	-
15	Lead (as Pb) mg/l, max	0.1	1.0	-
16	Cadmium (as Cd) mg/l, max	2.0	1.0	-
17	Hexavalent chro-mium (as Cr + 6),mg/l, max.	0.1	2.0	-
18	Total chromium (as Cr) mg/l, max.	2.0	2.0	-
19	Copper (as Cu)mg/l, max.	3.0	3.0	-
20	Zinc (as Zn) mg/l, max.	5.0	15	-
21	Selenium (as Se)	0.05	0.05	-
22	Nickel (as Ni) mg/l, max.	3.0	3.0	-
23	Cyanide (as CN) mg/l, max.	0.2	2.0	0.2
24	Fluoride (as F) mg/l, max.	2.0	15	-
25	Dissolved phos- phates (as P),mg/l, max.	5.0	-	-
26	Sulphide (as S) mg/l, max.	2.0	-	-
27	Phenolic compounds (as C6H50H)mg/l, max.	1.0	5.0	-
28	Radioactive materials: (a) Alpha emitters micro curie mg/l, max. (b)Beta emittersmicro curie mg/l	10^{-7} 10^{-6}	10^{-7} 10^{-6}	10^{-8} 10^{-7}
29	Bio-assay test	90% suivival of fish after 96 hours in 100% effluent	90% suivival of fish after 96 hours in 100% effluen	90% suivival of fish after 96 hours in 100% effluen

30	Manganese	2 mg/l	2 mg/l	-
31	Iron (as Fe)	3mg/l	3mg/l	-
32	Vanadium (as V)	0.2mg/l	0.2mg/l	-
33	Nitrate Nitrogen	10 mg/l	-	-

CONCLUSION AND RECOMENDATION

Industrialization, commercialization, growth in population are the important aspects that lead to increased contamination of water sources (Tyagi, et al., 2013). So it is of utmost important to ensure clean and hygienic water to the public (Tiwari, et al., 2008). For ensuring the clean and safe water, there are more treatments available and practiced throughout the world.

The conventional methods of treatment have its own challenges such as environmental hazards, economic feasibility, time spent, energy consumption etc. To overcome these limitations, there is a technology called Nanotechnology, which has its greater extent of application in water treatment area.Removal of contaminants in wastewater, such as heavy metals, has become a severe problem in the world. Numerous technologies have been developed to deal with this problem (Yang, 2019).

As an emerging technology, nanotechnology has been gaining increasing interest and many nanomaterials have been developed to remove heavy metals from polluted water, due to their excellent features resulting from the nanometer effect (Anjum et al, 2016).

Nanoparticle based treatment ensure ecofriendly, environmental friendly, cost-effective, energy and time saving approaches when compared to the traditional and conventional methods of waste water treatment (Prachi, et al., 2010). From the study it is recommended that proper treatment should provide to the industries for discharging waste water to the surface water or make it reusable and it is also recommended to adopt ecofriendly low cost technique for proper treatment of wastewater.

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Genetic Diversity of *Polygonum barbatum* in Yamuna Water by Using RAPD Molecular Marker

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ABSTRACT

The genetic diversity of *Polygonum barbatum* was analyzed using a RAPD primer. Three plants and water samples were collected from three different sites of Uttar Pradesh, viz. Shergarh ghat, Auraiya, from the banks of Yamuna and Poiya Ghat, Agra, again on the banks of Yamuna. These two plants were studied for variations from the plant from the third site, on the banks of Keetham Lake, used as a control. There was a large variation seen in these samples.

Keywords: *Polygonum barbatum*, Genetic diversity, RAPD.

INTRODUCTION

As stated by Bashir Ahmad *et al.* (2013), the genus Polygonum (Polygonaceae) comprises of about 150 species. Out of which, *P. perfoliatum*[Lian 1983], showed the antihypertensive property, *P.multiforum* [Yim *et al.* 1998], showed the property of myocardial protective action, *P. punctum*[Kott *et al.*1999] showed the antiviral property, whereas, a commonly found species, *Polygonum barbatum* has not been reported in any biological activities. So, I look into the genetic variation of the plant species. This plant showed carminative, astringent and cooling effects in folk medicine.

Recently, randomly amplified polymorphic DNA (RAPD) analysis has become a general method for estimating genetic diversity and variation among plant and cultivars (Ha *et al.,* 2001; Oiki *et al*., 2001; Wang *et al*., 2001; Shaw, 1995) and also characterizing genetic polymorphisms since it does not require probe DNA and detailed information about the genomic and population polymorphism (Hartl, 1999). Furthermore, the RAPD technique has several advantages over restriction fragment length polymorphism (RFLP) analysis, namely speed, low cost and the ability to analyze small amounts of samples (Um *et al*., 2001; Tochila-Komatsu *et al*., 2001).

RAPD analysis has been used to investigate the genetic diversity and phlogenetic relationships among the populations in many cultivated plant species (Hormaza *et al*., 1994; Arias and Rieseberg, 1995; Bonnim *et al*., 1996; Mimura *et al*., 2000). The number of studies using DNA analysis to clarify evolutionary relationships and classify species has proliferated over the past 25 years (Chris Brinegar, 2009). In the present study, RAPD molecular markers were used to investigate the genetic diversity of *Polygonum* L. 15 populations from different

regions in Southern Western Ghats were sampled and analyzed.

The purpose of the present study was to characterize the natural variations of *Polygonum barbatum* at molecular levels using a RAPD marker.

Materials and Methods

During the survey of sites, there were three locations selected for water samples during the pre-monsoons season. These three locations were:

1. Yamuna at Auraiya, near Etawah (coded as AU), the second site was;
2. Yamuna at Poiya Ghat at Dayalbagh, Agra (coded as PG), and the third location was;
3. Keetham Lake (coded as KL), situated at the outskirts of Agra district.

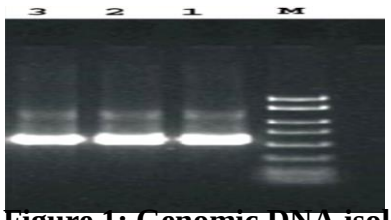
These three locations were chosen as based on the pollution load. Among all three sites chosen, Poiya Ghat at Dayalbagh, Agra, was the most polluted, as it is the direct cremation ground for the Hindus.

The next location was set on to the banks of Yamuna at Auraiya District. Auraiya is basically a rural place. The main use of water is in the irrigation. There is comparatively less pollution load in this area.

The third location is the conserved bird Sanctuary of Keetham Lake. This Lake is under the bird Sanctuary, so, it is under Govt. surveillance. That's the reason the pant chosen as a control was the plant collected from this site.

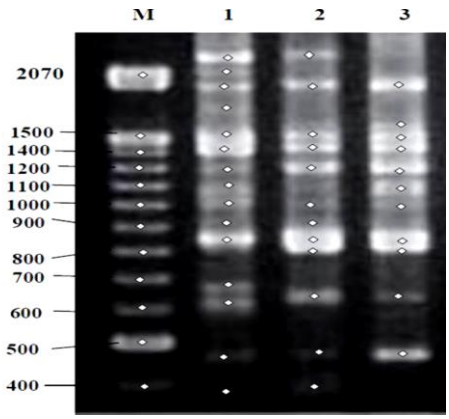
DNA from all the collected samples was extracted separately and RAPD was performed using the primer OPP-11 5' AAC GCG TCG G-3'. Now the water samples collected from all the three samples were tested for a pH test using a pH testing machine and the results were re-analyzed using the traditional pH strips.

Observations and Results: There were two photographs taken: One after the isolation of genomic DNA and the other After the RAPD analysis. The Photographs are underneath followed by the results.



Lane M = Marker (50, 100, 300, 500, 750, 1000bp, 1.5kb and 2kb)
Lane 1 = Keetham (KL)
Lane 2 = Poia Ghat (PG)
Lane 3 = Auraiya (AU)

Figure 1: Genomic DNA isolation



Lane M: Marker (600 -2070 bp)
Lane 1: Keetham (KL)

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REVIEW ON 3-D PRINTED MICRONEEDLE SYSTEM AS A NOVEL APPROACH FOR TRANSDERMAL DRUG DELIVERY

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ABSTRACT

The procedure of forming digital file from three dimensional solid objects is called 3D printing.3D printing technology is utilised in the field of fashion, food, art, human anatomy, biochemistry and biology. 3D printing is utilised in the field of drug delivery system e.g. pellets, patches, tablets, microneedles etc. 3D printed micro-needles are very safe to use and can be prepared easily with less time required whereas conventional microneedles are taking time to prepare and sterilization and high-tech equipment's to prepare the patch.We can make the personalized patch with different size, shape (such as round, cone, cylindrical), length, array format, patch area etc.

Key words- Microneedle, 3D-Printing, Transdermal Delivery

INTRODUCTION

3D printing is otherwise called added substance producing. The procedure of forming digital file from three dimensional solid objects is called 3D printing. Basically, the additive process is utilised to created 3D printing objects(Ligon et al., 2017). In this process, by setting down progressive layers of materials an object is built. Anyone of these layers can be seen as a delicately cut level cross-segment of the destined article. It procured an effect as a standard device in the car, aviation, and customer merchandise enterprises (Kreiger et al., 2015).

3D printing technology is utilised in the field of fashion, food, art, human anatomy, biochemistry and biology.This technology are utilised in building measuring device, to visualise molecules and for teaching anatomy (AbouHashem et al., 2015). The applications of 3D printing in various fields are given below:-

2. APPLICATION OF 3D PRINTING

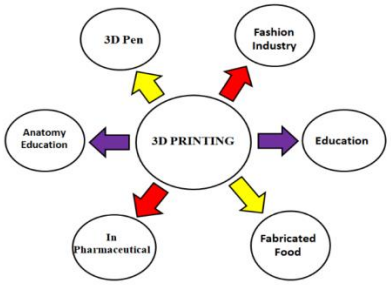


Fig.1.Application of 3D printing

2.1 Education: Utilizing 3D printing, scientists have made counterfeit models to define proteins, DNA, hybridization, crystal unit cells, nanostructures, complex orbital structures, steric communications, and energy surface models, among different themes. In spite of the utilization of these new models, the diminished hazardous pace of current innovation implies that models can take from a few minutes to hours to finish the creation of models that happen outside of ordinary class times(Bernard & Mendez, 2020).

2.2 3D pens: - Another energizing option in contrast to standard 3D printers is 3D pens. These gadgets radiate a slim layer of plastic by melting the string or by utilizing light to clean the monomer blend, much like to marketable 3D printers. This free structure measure has been acknowledged by some in expressions of the human art community, yet the absence of precision makes applications in science teaching and different fields is troublesome (Bernard & Mendez, 2020).

2.3 Fashion industry: 3DP is utilized in the fashion business to create models, high fashion exercises, and modified items that give customers a cooperative open door driven by decision.Nike has utilized SLS to create models and to make lightweight end plates connected to the Vapor Laser Talon and Vapor High Agility football spikes.

High fashion style creators are likewise utilizing 3DP to convey in manners that arising innovations can be utilized to configuration new form. London designer Catherine Wales uncovered her Project DNA assortment of corsets, masks, and 3D caps at the Arnhem Mode Biennale in the Netherlands(Vanderploeg et al., 2017).

2.4 Anatomy education: -3D printing, in the course of recent many years, has been utilized effectively in an assortment of clinical fields, including education. In anatomy, excellent 3D printed writings of cadaveric material have as of late been delivered for instructive purposes.

3D bones are printed and acquainted with understudies in anatomy education. This has been accomplished through various strides for the orientation community between the two-participatinguniversities. The venture was a continuation of the existing partnership between the two

universities in the field of biomedical schooling. It utilizes assets and framework (3D surface scanners, printers, bone collections, and so on), just as aptitude in the two universites, empowering the creation of excellent scanners and printing and expanding the number and variety of osteological tests(AbouHashem et al., 2015).

2.5 Food industry: -There is a developing business sector interest for personalized food items, a large number of which are at present designed and made by exceptionally trained artists. The expense of a set number of pieces is high. 3D food printing likewise called Food Layer Manufacturing(J. Sun et al., 2015). Fabricated foods generally composed of many ingredients such as proteins, lipids, simple as well as complex carbohydrates and emulsifier which can be interact with each other and capable to modify the final food characteristics(Pulatsu & Lin, 2020)

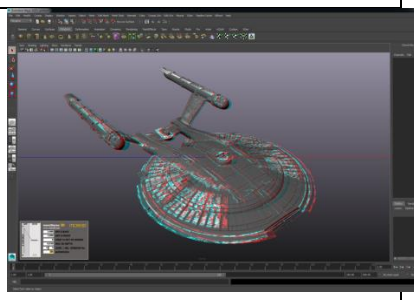
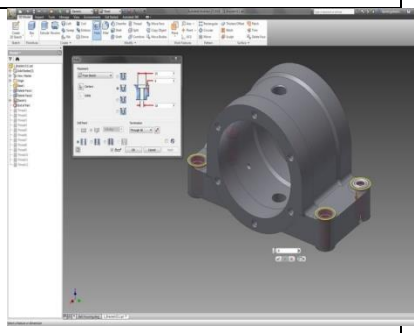
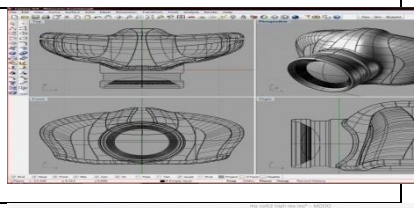
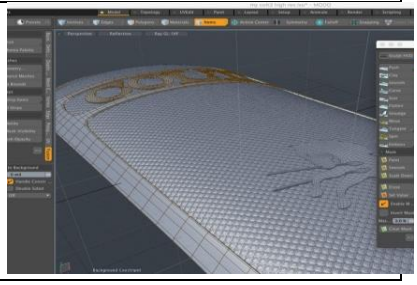
Food printing incorporates 3D (3DP) printing and advanced gastronomy procedures to personalized food pieces in bulk in shape, shading, taste, texture, and amount of healthy food. 3DP is an advanced controlled automated building process that makes a layer of solidforms with layers and uses phase change or compound responses to tie layers together. Computerized gastronomy is the utilization of food measure information in the production of food with the goal that our food information can beyond taste to coordinate all parts of gastronomy(J. Sun et al., 2015).

2.6 Drug discovery:-The utilization of this innovation in the field of medication conveyance has been researched and as of late embraced with the FDA's approval of a 3D printed tablet, Spritam (levetiracetam), which keeps on supporting the capacity of 3D printing to make complex and personalized simulation structures(Kazi & Jasvi, 2016). The advantages of utilizing extra production methods as measurement structure incorporate the capacity to precisely control the distribution of the active pharmaceutical ingredient (API) segment inside the dosage form, produce complex geometries, apply an insignificant store for API, diminish squander and consider quicker computational execution(Jamróz et al., 2018).To get ready for the limit of the limit with respect to every person. Business motivations related with drug printing incorporate distantly chains of complex, slow, and costly customary supply chains, limiting production waste and stock, and permitting singular rating structures without the requirement for high-volume production(Prasad & Smyth, 2016).

3. SOFTWARE USED IN 3D MODEL (table form)

In order to make good use of the 3D printer, models must be made into a 3D modeling system that is ultimately sent to the printer to be printed as a visual. There are various types of modeling software used in the 3DP industry(L. Sun & Zhao, 2017). These programs range from a basic system to furthering a system.

Table 1: list of various software name, structure and there uses.

Sr. No.	Software Name	Uses	Structure
1	Maya https://www.autodesk.com/products/maya/overview?term=1-YEAR&support=null	It is applicable for advanced users and professionals. It is beneficial because of its procedural effects and powerful world and character creation tools. It is primarily marketed at animation professionals, Maya is useful for many aspects of 3D modeling, especially in terms of mathematically smooth surfaces and shapes.	
2	3DS Max https://www.autodesk.com/products/3ds-max/overview?term=1-YEAR&support=null	It is applicable for advanced users and professionals. Another program that focuses on animation, 3DS Max offers some great 3D modeling features such as shading tools, parametric mesh modeling, and polygon modeling.	
3	Inventor https://www.sculpteo.com/en/glossary/inventor-definition/	It is applicable for advanced users and professionals. Tailored specifically for product design and engineering applications and loaded with tools for simulation and manufacturing. Inventor 3D CAD software offers professional-level 3D mechanical design.	
4	Rhino3D https://www.rhino3d.com/	It is applicable for advanced users and professionals It is very powerful and full of features for modeling, analysis, rendering, 3D capture, CAM, and 3D printing.	
5	Modo https://www.foundry.com/products/modo	It is applicable for amateurs to professionals. Its Procedural modeling and artist-friendly tools for modeling, animation, texturing, and rendering.	

A separate program falls under the category of computer-aided drug design (CAD). CAD is used in various industries and is very important in 3DP. Since you have the 3D model, the subsequent stage is to set up your 3D printer file. This is called slicing(Jain et al., 2018).

3.1 Slicing: From 3D Model to 3D Printer Slicing is partitioning a 3D model into hundreds or thousands of horizontal layers and is finished with slicing programming. Some 3D printers have an underlying slicer and let you feed the raw.stl, .obj, or even CAD record. At the point when your record is cut, it's fit to be taken care of to your 3D printer. This should be possible through USB, SD, or the web (C. Guo et al., 2019).

Additionally, there are other terms to be familiar with(Gokhare et al., 2017)

- Slicer (also called slicing software): software used in the majority of 3D printing processes, converting 3D objects to specific printer instructions.
- Fused deposition modeling (FDM): a 3D printing process that uses an ongoing filament of a computer-controlled, thermoplastic material to create a printed shape for objects.
- Parametric 3D printing: refers to the model being defined by individual parameters (specific lengths, heights, and widths, which are editable during and after the modelling process.
- G-Code: a standard programming language for 3D printers that contain commands to move parts within the printer.

3.2 Advantages and disadvantages of 3D printing

Table 2:- list of Advantage and Disadvantage of 3D printing technology.

Advantage of 3D printing (Berman, 2012; Gokhare et al., 2017; Kalaskar, 2017)	**Disadvantage of 3DP**(Berman, 2012; Gokhare et al., 2017; Kubáč & Kodym, 2017)
✓ Faster production ✓ Rapid prototyping ✓ Easily accessible ✓ Flexible design ✓ Better quality ✓ Print on demand ✓ Tangible design and product testing ✓ Strong and lightweight parts ✓ Cost- effectives ✓ Faster design and production ✓ Minimizing waste ✓ Environmental friendly ✓ Less waste production ✓ Advanced healthcare ✓ Risk reduction	✓ High energy consumption ✓ Limited material ✓ It is very expensive technique ✓ Restricted build size ✓ We can use only some materials ✓ 3D printers are not common to used ✓ Injuriousdischarges ✓ Too much dependence on plastic ✓ 3D printers are moderate ✓ Production of perilous weaponry ✓ Copyright encroachments ✓ Manufacturing job losses

4. SCOPE OF 3D PRINTING IN DRUG DELIVERY

3D printing is utilised in the field of drug delivery system e.g. pellets, patches, tablets, microneedles etc.

4.1 Film

(Jamróz et al., 2017)worked on the orodispersible film with the help of 3D printing technology based on hot-melt extrusion. The group prepared an orodispersible film of a poorly soluble drug using a fused deposition modeling technique. The developed film had the added advantage of giving a higher dissolution rate.

(Jamróz et al., 2017)used the aripiprazole as a drug model with cyclodextrins, polyvinyl alcohol as a polymer to fabricate oro-dispersible films. Fused deposition method was found to be aappropriate method for the production of aripiprazole containing oro-dispersible films with easy reform shape and drug content.

(Ehtezazi et al., 2018)developed a make a fast-dissolving Ibuprofen, paracetamol oral film by FDM.

(Tagami et al., 2019)reported a mucoadhesive Catechin film by a hot-melt extrusion method.

(Wang et al., 2017)made an active 3D patch of tetracycline hydrochloride by the electrohydrodynamic (EHD) printing technology.

(Khaled et al., 2014)they prepared the controlled release bilayer tablets of Mucinex by using the Extrusion printer. They prepared the 2 layers of tablet, the first one for immediate release and the second layer for the sustained release.

The first layer composition is HPMC2208, PAA, methocel K100M were used for sustained release hydrophilic matrix and second layer polymer composition is HPMC2910, MCC, SSG were used as an immediate release and Mucinex used as a active ingredient and other solvent with analytical grade for this experiment.

The result of this demonstration is successful and we get a hope for future to make a personalized care and treatment with least cost.

4.3Pellets: -

(Awad et al., 2019)they prepared the pellets for multiple drug (paracetamol and ibuprofen) for controlled release pattern with the help of Selective laser sintering 3DP technique.They used the paracetamol and ibuprofen as active ingredient for loading and ethyl cellulose, kollicoat (for instant release), PVA, PEG,used as a polymer and span 80 used as a binder and other solvent used as analytical grade.

SLS 3DP was effectively used to make mini-printlets in two distinct measurements, 1 mm to 2 mm. Previously Paracetamol was used as the model medication and ethyl cellulose was used as the primary polymer grid.

Double miniprintlets for multi-drug treatment were likewise created, fusing paracetamol and ibuprofen in various layers. Like the single miniprintlets, the double miniprintlets were imprinted in two distinct sizes,

1 mm and 2 mm. The double miniprintlets were set up in two diverse configurations, wherein one medication was scattered in Kollicoat IR, a polyvinyl liquor/polyethylene glycol unite copolymer with immediate release characteristics, and the other medication was scattered in ethyl cellulose.In this work, we showed that smaller than usual printlets arranged utilizing SLS 3DP offer a novel drug delivery approach with high flexibility and power over the drug content and release properties.

4.4 Microneedles: -

(Pere et al., 2018)work on theinsulin skin delivery with the help of 3D printed microneedles. They use the stereolithography technique for the preparation of polymeric microneedle patches for the delivery of insulin by transdermal delivery. They prepared microneedles in a cone shape.

They used insulin solution for loading active ingredient and xylitol, trehalose, mannitol, class-1 resin as a polymer and other solvents were of analytical grade.

They use the inkjet printing for the coating layer of xylitol, trehalose, mannitol for accurate and reproducible. And the result of this experiment is a 3D printing stereolithographic procedure was presented for the creation of microneedle designs for insulin transdermal delivery.

5. INNOVATION OF 3D PRINTING TECHNOLOGY: -

Table 3:- list of invention of 3D printing technology.

Sr. No.	Year	Machine name	Reference
1	1980	Dr. Kodama for his first tries in quick prototyping in 1980. He was the pioneer in added substance fabricating method and presented stereolithography which utilized photosensitive resin polymerized with the guide of UV light.	(Bala et al., 2016)(Pravin & Sudhir, 2018)
2	1983	Charles (Chuck) Hull, invented SLA machine	(Bala et al., 2016)
3	1984	Alain Le Méhauté, Olivier de Witte and Jean Claude André reported their patent for the stereolithography	(Kazi & Jasvi, 2016)
4	1986	The 1st patent was given for stereo lithography apparatus (S.L.A)	(Bala et al., 2016)
5	1987	SLA-1, was introduced and sold in 1988	(Bala et al., 2016)
6	1987-89	Carl Deckard documented a patent in the US for the Selective Laser Sintering (SLS) RP measure. This patent was given in 1989.	(Bala et al., 2016) (Pravin & Sudhir, 2018)
7	1989	Scott Crump filed a patent for Fused Deposition Modeling	(Bala et al., 2016)

		(F.D.M)- the proprietary innovation	
8	1993-99	Significant parts in 3Dprinting thought of different methods like ZCorpbinder jetting from MIT and Arcam MCP innovation and Selective Laser Melting.	(Bala et al., 2016)
9	1996	Sanders Prototype (later Solid-scape) and Z Corporation were set up	(Bala et al., 2016)
10	1997	Arcam was established	(Bala et al., 2016)
11	1998	Objet Geometries launched	(Bala et al., 2016)
12	2000	MCP Technologies (a set up vacuum projecting OEM) presented the S. L. M innovation	(Bala et al., 2016)
13	2002	Envision Tech was founded	(Bala et al., 2016)
14	2009	The main economically accessible 3D printer in kit form and dependent on the RepRap idea was offered available to be purchased.	(Bala et al., 2016)

6. MACHINES AND THEIR FEATURES UTILISED IN 3D PRINTING

Table 4:- list of 3D printer and there features.

Techniques/machine	Characteristic features	Advantages	Disadvantages	Reference
Binder deposition method	The essential 3D printing innovation utilized for drug creation is inkjet affirmation on powder beds. Inkjet printers splash details of medications or fasteners in little drops at exact rates, movements, and sizes onto a powder bed. The fluid detailing inside the printer may contain a cover in particular, and the powder bed may contain the dynamic fixing (API) with extra excipients. On the other hand, APIs can be flown onto powder	1. full colour options 2. No warping and shrinking of product in different temp.	1. low part strength 2. less accurate material jetting	(Kunchala & Kappagantula , 2018)

	beds as arrangements or nanoparticulate suspensions. Binder Jetting is an added substance fabricating measure in which a fluid restricting specialist is specifically kept to join powder particles. Layers of material are then attached to frame an item**.**			
Direct write: - Direct-Ink-Writing (DIW)	It is an expulsion based added substance fabricating strategy intensely used in meso-and small sizes. In DIW, the fluid stage "ink" is apportioned out of little spouts under controlled stream rates and stored along carefully characterized ways to manufacture 3D designs layer-by-layer. Utilizations a PC controlled translational stage that moves an example producing gadget to accomplish, layer-by-layer, 3D microstructure.	**1.** no entrapment of particles in pores 2. high fabrication speed	**1.** low accuracy 2.easy to sag and collapse during printing	(Zhang et al., 2015)
Fused deposition modelling (FDM)	FDM printers utilize a thermoplastic fiber, which is warmed to its softening point and afterward expelled, layer by layer, to make a three-dimensional article. FDM was the method protected	1. low cost 2. fast and acceptable strength	1. nozzle clogging 2. limitation in usable material	(Long et al., 2017)

	by Scott Crump, prime supporter of Stratasy ltd and was created because of the constraints found in inkjet printing. It involves the softening, expulsion, and layer by layer testimony of materials that after cementing bring about items with foreordained constructions.			
Inkjet printing	Mix of dynamic drug fixings and excipients are definitely splashed on the substrate as beads dependent on two procedures, that is, nonstop and drop on interest. In persistent jet printing, the flood of drops are consistently sprinkled on the substrate or digressed towards the waste line when not being used. Nonetheless, in drop on interest technique, the necessary number of drops are sprinkled on the substrate and shut when not out of luck.	1. high resolution 2. control in drop size and ejection rate	1. high viscous bio-inks can't be used 2. weak mechanical integrity of the construct	(Y. Guo et al., 2017)
Material extrusion	Material Jetting forms objects in a comparative technique to a 2-dimensional ink jet printer. Numerous materials can be utilized in one cycle and the material can be changed during the form stage. Material is streamed onto the form stage surface in drops, which are framed utilizing a swaying	1. Accuracy 2. Good surface finishes.	1. Build process is slow 2. Limited no. of wax like materials	(Chaunier et al., 2018)

	spout. The material is expelled from mechanically incited spouts. Dissimilar to cover streaming, which requires a powder bed, expulsion techniques can print on any substrate. Normal kind of expulsion printing is intertwined fiber creation (FFF), likewise known by the reserved name: melded affidavit modeling™ (FDM®).			
Extrusion method	Material is expelled from the mechanized nozzle onto the substrate. As in powder bed statement, it doesn't have powder bed and need higher help material. The materials that can be expelled are liquid polymers, suspensions, semisolids, glues.	1. wide range of material choice 2. good mechanical properties	1. limited material for thermoplastic 2. viscosity and temperature of materials	(Hwang et al., 2018)
Pen based 3D method	This is a refreshed adaptation of expulsion procedure as hand-held gadget to plan wanted designs which are generally deficient. Likewise, theresearchers are thinking about its significance in surgeryfor affidavit of 3D designs materials.In this interaction, the layer by layer gathering is physically controlled with hand held gadget.	1. very low cost 2. easy to use	1. extruder in human controlled	(Kara et al., 2006)
Powder bed	It includes the combination or	1. wide material	1. long print time	(S. Sun et al.,

fusion method	restricting of low liquefying point with high dissolving point covers. The laser shaft supplies the warmth needed for the limiting. It is a quick interaction, yet nearly more mind boggling than expulsion technique. The Powder Bed Fusion measure incorporates the accompanying usually utilized printing strategies: Direct metal laser sintering (DMLS), Electron shaft liquefying (EBM), Selective warmth sintering (SHS), Selective laser dissolving (SLM) and Selective laser sintering (SLS).	choice 2. low cost and minimum support	2. weak structure property	2017)
Selective laser melting	It is a fast prototyping, 3D printing, or added substance fabricating (AM) procedure intended to utilize a powerful thickness laser to soften and meld metallic powders. To many, SLM is viewed as a subcategory of specific laser sintering (SLS). The SLM cycle can completely liquefy the metal material into a strong three-dimensional part not at all like SLS.	1. no support material is required 2. good material property	1. low mechanical strength 2. not suitable for large objects	(Wei et al., 2019)
Stereolitho-graphy	Stereolithography includes presenting fluid tars to bright or other high-fuel light source to	**1.** fine control over pore shape and size	1. slow process 2. required supportive	(Manapat et al., 2017)

	instigate polymerization responses. The procedure utilizes photopolymerizable crude material. An illustration of medication conveyance application is 3D printing of photopolymerizable hydrogels	2. ability to fabricate complex geometries	material	
Sheet lamination method	It is an automated laser-cutting and sheet-by-sheet assembly of products. This process is quick and inexpensive although it has lower solution and more useful than most printing methods.	1. multi material layers possible 2. Faster print time, but post processing will be required.	1. limited material options available 2. Hollow part are difficult to produce in some type of SLM**.**	(Bhatt et al., 2019)
Direct energy deposition method	In this interaction the crude materials are dissolved by a laser or electron shaft fuel sources as they are stored. This strategy utilizes the material that can't be expelled like powder or other crude materials.	1. reduce material waste 2. easy material change	1. low build resolution 2. no support structures	(Miedzinski, 2017)
Thermal inkjet printing	Thermal inkjet printer comprise of miniature resistor, when current is instigated, this warmth, warms up the watery ink liquid which changes over it into fume structure that moves out of a nozzle bringing about bead structure. This procedure requires high temperature that may corrupt the warmth delicate material.	1. high resolution 2. accuracy 3. wide range of material	1. May damage post processing. 2. delicacy of the 3D printed features	(Hoath, 2016)
Zip dose	This procedure was created by MIT in late 1980's. Give a	1. high drug load 2. use highly	1. requires access to small amount	(West & Bradbury,

	customizedportion notwithstanding the conveyance of high medication stacked with high crumbling and disintegration level by assembling profoundly permeable material. This procedure is utilized for forming a tablet with high portion and fast deterioration.	porous material 3. wide range of products	of liquid 2. costly	2019)

8. CONCEPT OF TRANSDERMAL DRUG DELIVERY: -

Transdermal therapeutic systems are characterized as independent, self-discrete dosage forms, which when applied to the unblemished skin convey the medication at a controlled rate to the systemic circulation. A simple patch that you stick onto your skin like a bandage, which act as a passive diffusion of medication across the skin as the delivery mechanism. TDDS are dosage form intended to convey a remedially powerful measure of medication across a patient's skin(Brown et al., 2006).

Advantage of TDDS: -

- ✓ Avoid first pass metabolism
- ✓ Improve patient compliance
- ✓ Prolong time of action
- ✓ Reduce frequency of dosing
- ✓ Uniform drug level in plasma
- ✓ Increase therapeutic efficacy

TDD isn't in every case normally achievable. The significant restriction of this route comes from the nature of the skin boundary itself. The external most layer of the skin, the Stratum Corneum plays the dominant role in the impermeability of the obstruction, being extremely thick and significantly low in hydration (15–20%)(Economidou et al., 2018).

The first transdermal system, Transdermal SCOP was authorized by FDA in 1979 for the avoidance of nausea and vomiting associated with level(Prausnitz & Langer, 2008). Most transdermal patches are intended to deliver the active ingredient at a zero-order rate for a time of a few hours to days following application to the skin. This is particularly profitable for prophylactic treatment in chronic conditions(Mehta, 2004).

9. CONCEPT OF MNS DRUG DELIVERY: -

Back in 1976, microneedles were first discovered and till 2000s the innovation employed to produce needles of micron measurements was not comprehensively accessible. The microneedles are empty needle like structure having a size ranging from microns and length measures up to 1micrometer that is adequate to permit going of a liquid and solid medication through the microneedle. The empty shafts can be straight, for example extended from base to tip, and having atleast one or more opening on the sides from the lateral side of the needle instead of having only opening at the tip(Prausnitz, 2004).

Microneedles can be installed inside transdermal drug delivery. Microneedles are invented to pass through the epidermis layer till a profundity of 70–200 micrometer, because of short and thin structure of the microneedle they are not able to pass to nerves through the dermis layer that's gives the painless delivery of active pharmaceutical ingredients (APIs) of small and higher molecular weight. 47 In comparison of other transdermal drug delivery microneedles are more capable in delivering accurate amount drug at site of action(Hao et al., 2017).

Advantages of microneedles(Sivamani et al., 2007)**: -**

• Large molecules can be managed

• Painless administration of the active pharmaceutical ingredient.

• First-pass metabolism can be avoided

• Faster recovery at injection site than with a hypodermic needle

• No trypanophobia.

• Ease of administration of drug.

• Decreased microbial penetration as associated with a hypodermic needle, the microneedle penetrates only the epidermis layer of skin.

• Specific skin region can be focused for wanted medication conveyance improved medication efficacy may bring about portion decrease

• Good tolerability without long-term oedema or erythema

• Rapid medication conveyance can be accomplished by coupling the microneedles with different technologies

Disadvantages of microneedles(Indermun et al., 2014)

Cautious utilization of the gadget might be expected to keep away from particles 'skipping off' the skin surface. The thickness of the stratum corneum and other skin layers fluctuates among people and so penetration depth of particles could change as well

• The outer climate, similar to hydration of the skin, could influence delivery.

• Repetitive infusion may fall the veins

• The tip of the microneedle may sever and stay inside the skin on expulsion of the fix

9.1 Types of microneedles based on drug delivery

9.1.1Solid microneedles

As the name suggests, it is entirely solid and work by creating the hole in Stratum Corneumof the layer of skin. As the medication are coated on the upper surface of solid microneedle, it deliveredatthe site of action by puncturing the stratum corneum layer of skin and would be removedafter the delivery and whole process of drug delivery is shown in. It alsoincreases the permeability of skin by creating hole on skin layer so that applied drug caneasily reaches the site of action with minimal loss and less amount of time. The size of solidmicroneedle varies between 750-1000μm in length and comparison with hypodermic needle formulated a PLA composed microneedle of size of 600micrometre to increase the delivery of small molecule drugs across the skin(Prausnitz, 2004)(Hao et al., 2017).

Materials used for the formulation of Solid Microneedle(Chen et al., 2018)**: -**

Silicon: Manufacturing solid microneedle using silicon is costly and has disadvantage of being brittle and have possibility of breaking down in skin.

Metal: Microneedle formulated using metals are generally have good mechanical strength and manufacturing cost is also low. Various metal involved during the formulation of solid microneedle are stainless steel, gold, platinum, titanium, nickel, iron, etc.

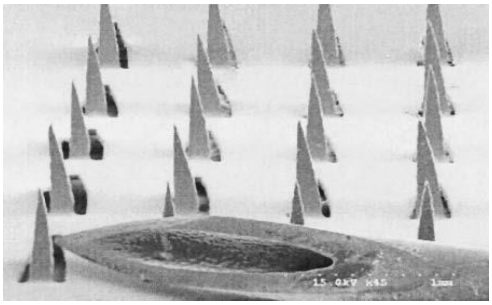


Fig.2 Figure illustrating relative comparison of solid microneedle with hypodermic injection.

Biodegradable materials such as PCCP [Poly (di(carboxylatophenoxy) phosphagene)] consisting of phosphorus-Nitrogen provides potent adjuvant activity and also overcomes the limitation of metal and silicon made solid microneedles.

9.1.2 Coated Microneedles

Coated Microneedle are those which consists of coating of drug on its surface. This microneedle allows the diffusion of drug from surface to deep epidermal layer of skin. But due to coating it increases the thickness of the microneedle and can influence the penetrating ability of microneedle. Despite this limitation, the coated microneedle found great utility in vaccine delivery across the skin(Prausnitz, 2004)(Hao et al., 2017).

9.1.3 Dissolving / degradable microneedle

Dissolving or Degradable microneedle patch is manufactured with the help of soluble/degradable polymer materials with drug / molecules with tangled in polymeric matrices. Drug is released form patch through the dissolving or biodegradable of the polymer & rate of drug release is organised by the dissolving or degradable amount of polymer media of microneedle. Dissolving or degradable microneedle patch can be employed for alter deliveryof protein(Hao et al., 2017)(Prausnitz, 2004).

Material used: Polycarbonate, PVP, PLA, PLGA, PGA, PVP etc. Other materials like fast-dissolving sweeteners and also various polysaccharides have been searched to formulation of the dissolvable microneedles. Another mucoadhesive polymer such as Gantrez AN-139 can also be used due to advantage of withstanding higher compression pressure(Chen et al., 2018).

Advantage(Kwon et al., 2017)(Waghule et al., 2019)**: -**

- Transferring large doses of drug.
- Dissolving microneedles have been developed for vaccine delivery.
- The best choices for long-term therapy with improved patient compliance.

Disadvantage(Kwon et al., 2017)**: -**

- It's hard to get a deliver a fixed amount of drug.

9.1.4 Hollow Microneedle

As the solid microneedle dramatically increases the skin permeability, still there is need of some more controlled and reproducible drug delivery system. In this scenario, Hollow Microneedle found its application as it provides more accurate and controlled drug delivery. Hollow microneedles are hollow inside their shaft and have various advantages such as option of delivering both high and low molecular weight drug in according to need of body, possibility of pressure driven movement of drug instead of passive movement and reduces the chance of cross contamination of surrounding with deliverables. Various type of hollow microneedles are fabricated for transdermal drug delivery such as Metal Hollow Microneedles made of metal, Silicon hollow microneedle made up of silicon and of glass microneedle(Prausnitz, 2004)(Hao et al., 2017).

Method of manufacturing: -

Hollow MNPs can be created from metal through metal electro-deposition joined with master shape, in which master shape is made by means of the strategies referenced in Section 3.1 and after sputtering a conductive seed layer onto the master shape, metal is electrodeposited into the master shape to frame the hollow MNs. In addition, metal hollow MNs can be manufactured by means of two phase Electro-deposition, in which the hollow design is created by twice electro-deposition.

Silicon hollow MNPs can be created by dry etching or a mix of dry and wet etching (Chen et al., 2018; Sivamani et al., 2007).

Advantage(Kwon et al., 2017)(Waghule et al., 2019)(Sivamani et al., 2007)**: -**

- Hollow microneedles have been developed for vaccine delivery.
- It is used for high molecular weight compounds such as proteins, vaccines, and oligonucleotides.
- Drug flow rate and release pressure can be adjusted.
- Capable of administering a large dose.

Disadvantage: -

- Dependent on the flow rate of the microneedle.
- Can formation of clogged.

10. Fabrication microneedles: -Manufacture of microneedles are cut from stainless steel sheets utilizing an infrared laser. The ideal microneedle shape and measurements are first drafted in AutoCAD programming. Utilizing this plan laser energy is utilized to cut the microneedles. A cutting rate of 2 mm/s and air cleanse at a steady pressing factor of 140 kPa is utilized. Microneedles are either set up as in-plane needles or as out of the plane microneedles Laser cutting(Sivamani et al., 2007).

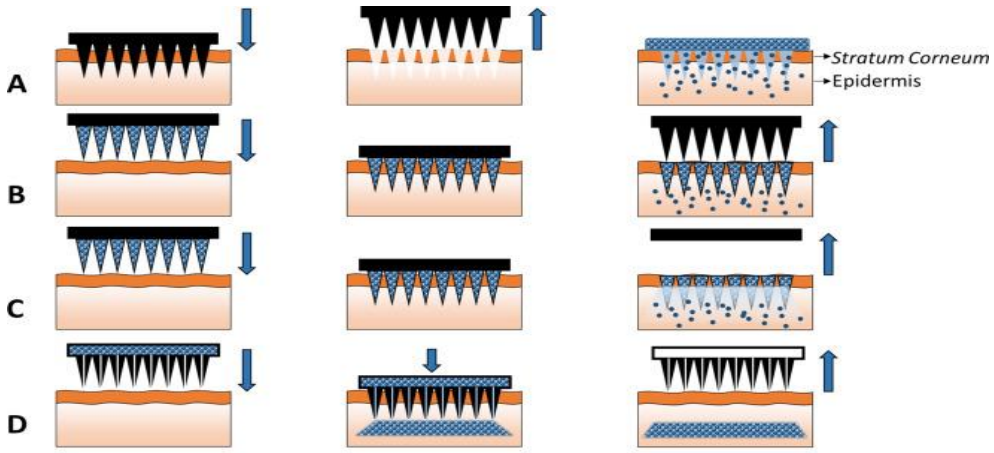


Fig.3: Systematic representation of drug delivery through different types of microneedles.

[A. Solid Microneedle B. Coated Microneedle C. Dissolvable Microneedle D. Hollow Microneedle]

Table 5:- Different types of microneedles

S. no.	Type	Material	Fabrication method
1		Stainless-Steel	Infrared laser cutting
2		Stainless Steel	Wire electrical discharge machining
3		Tungsten	Deep reactive ion etching

4	Solid	Titanium alloy	Ion sputtering deposition
5		Tantalum	Twisted light with spin
6		Silicon	Photolithography + etching
7	Hollow	Palladium	Two stage electrodepositions
8		Hafnium oxide	Atomic layer deposition + master mold
9		Silicon	Dry etching
10		Silicon	Combination of dry and wet etching
11		SU-8	Photolithography
12		Glass	Drawn-glass micropipette
13	Dissolving	Fibroin	Solvent casting+vacuum
14		Maltose	Melt casting
15		Gelatin	Solvent casting + centrifiugation
16		Hyaluronic acid	Solvent casting
17		Alginate	Solvent casting + centrifiugation

10.1 Benefits of microneedle prepared by 3D printing over conventional preparation techniques: -

3D printed micro-needles are very safe to use and can be prepared easily with less time required whereas conventional microneedles are taking time to prepare and sterilization and high-tech equipment's to prepare the patch.

We can make the personalized patch with different size, shape (such as round, cone, cylindrical), length, array format, patch area etc. The same was mentioned by(Bhatnagar et al., 2018; Jamróz et al., 2018).

It'simproves the penetration power of MNs patch. Whereas conventional preparation of MNs patch is very difficult to relay impossible to make a personalized MNs patch because in take so much time to formulate patch (Ita, 2017).

In conventional techniques we need different product and procedure for making different type of patch such as solid MNs, Hollow MNs, and dissolving MNs whereas in 3D printing technology we need just one technology with help of a computer software and printer(Bariya et al., 2012).

In conventional techniques for preparation of MNs we need metal and different tech such as infrared laser for the cut needle structures from stainless steel sheets and form a Solid micro-needles patch, and electrodeposition combined with master mold to form a Hollow microneedles patch(Chen et al., 2018), in dissolving microneedles we use Centrifugation, vacuum and pressure are adopted the MN structure(Chen et al., 2018). After the cutting and successful formation of MNs, then manually bending needle at 90° out of the plane of the sheet. whereas 3D printing technology need a computer software and

3D printer to prepare a MNs on sheet we just need an extrusion of polymeric solution and start the preparation of MNs(Bariya et al., 2012).

3D printed MNs are very safe to use and easy to remove and it not causing pain because it prepared by bio-degradable polymer which is non-toxic for us. Whereas conventional prepared MNs cause pain and burning in site of administration and some time it can cause the inflammation due to metal and stainless steel(Cheung & Das, 2016). Polymers used in microneedle drug delivery(Park et al., 2005).

Table 6:- Published literatures of microneedle drug delivery by 3D printing technology

Sr. no	dosage form	Drug	Polymer	3DP technology	Reference
1	Micro-needles	Insulin	mannitol and xylitol (drug carriers), Class I resin (polymer)	Stereolithography, inkjet print	(Pere et al., 2018)
2	Micro-needles	Computational design of microneedles	Trimethylolpropane triacrylate, Polyacrylic acid, photopolymerizable, derivatives of polyethylene glycol and polycaprolactone	Continuous Liquid Interface Production	(Johnson et al., 2016)
3	Micro-needles	Biodegradable polymer microneedles	polylactic acid, PVA	fused deposition modelling	(Jamróz et al., 2017)
4	Micro-needles	insulin delivery	photopolymeric resin,	Stereolithography, inkjet printing	(Economidou et al., 2019)
5	Micro-needles	Biodegradable polymer	Hydrogel, PVP, PDMS	Stereolithography 3D printing	(Foundation et al., 2015)

				(Objet Eden350, Stratasys, Ltd., Edina, MN, USA).	
6	Micro-needles	Cisplatin, retinoic acid, rapamycin	PVC, PVA, PEG	Stereolithography, inkjet dispensing	(Bhatnagar et al., 2018)
7	Micro-needles	Besifloxacin	PVA, PVP K-30	Poly-jet 3D printer	(Yao et al., 2020)
8	Micro-needles	Hydrogel based	PEG400DA, Phenylbis phosphine oxid	Digital light processing	(Yao et al., 2020)

CONCLUSION AND FUTURE PROSPECT OF 3D PRINTING

3D printing technology successfully worked on various field, but in pharmacy 3D printing technology has very excellent growth in a various formulation such as bilayer tablets, multiple compartment capsules, pellets, films, and patches. In microneedles patch, 3D printing technology has very exponential power to produce a better patch with less time and less material.

3D fabricated MNs patch can we used as a personalized patch with a change in their size, shape, needles size, and their location from the sheet. We can administer drugs in different layers of skin by changing the degree of the attached microneedle. Recently, we have several 3D printers to use the formulation of MNs patch as we read above but, in those printers, if we add the outer accessories with the 3D printer so it improves the efficacy and production rate. For example, if we can add isotropic shrinkage technique with 3D printing technology so it will call a print-and-shrink fabrication technique which allows the creation of complex shape polymeric needles. And we have several issues with FDM and inkjet printer but we can cure by working and optimizing those printers.

Future work includes improving the FDM 3D printer's nozzle configuration to upgrade the goal without raising the expense altogether or building up a method that will take into consideration more adaptable MNs. By upgrading the resolution, more characterized shapes can be made, which would bring down the measure of time required for etching. With the headway of 3D imprinting in industry, especially late business dispatches of 3D printed items, this technique gives a versatile manufacturing of MNs. This novel formulation method has shown the capability of fast prototyping MNs at low expenses, overcoming any issues between additive manufacturing and inactive medication delivery (Jamróz et al., 2017).

Because of the cheap in cost, pain free, short manufacturing time, well biocompatibility, and medication

conveyance execution properties of 3D constructed MNs, it is energizing to adjust MNs to the market. We hope to apply 3D printed MNs with properties above to clinical use in future(Yao et al., 2020).

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Impact of Educational Intervention Programme on Self Esteem of Rural Adolescent Girls of Ludhiana District of Punjab

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ABSTRACT

The study was conducted on self-esteem of rural adolescent girls of five villages namely Hassanpur, Gahaur, Bahanur, Mansuran and Mohie of district Ludhiana. The girl students enrolled in 10th, 11th and 12th classes in each of the five government senior secondary schools were selected for the study. The total sample comprised of 153 girl students. The pre test was done on rural adolescent girls to know about their level of self esteem and it was found that the girl showed medium level of self esteem. Hence, **n**eed based intervention was imparted to enhance their self esteem. Post intervention results indicated that Intervention helped in improving their self esteem as all the girls fell in the higher category in the following aspects like getting things they desired, confident about decision making, having more of success than failure, acceptance by people and successful at handling social interactions etc. The girls were helped to be confident and have a good personality with number of attempts and various methods.

Introduction

Adolescence is a concept encompassing physical and emotional stages of transition from childhood to adulthood. With the dramatic physical changes and development, adolescents worldwide find themselves in a situation characterized by an uncertain status and events might affect their concept of their own. (Shipra e.tal 2008) Self-esteem has been described as the judgments that we make about our own worth and the feeling associated with those judgments. It has been ranked as among the most important aspects of self-development since evaluation of our own competencies affect emotional experiences, future behaviour and long term psychological adjustment. Girl child in India and that also in rural areas is still looked at as a burden. Born in an unwelcoming environment, treated as unwanted child, girls' face many problems in life like- undernourishment, inadequate health care, lack of access to education and not much exposure for better opportunities etc. With changing times, gender perceptions are a societal construct, which are dependent upon socio-cultural practices in which the children, adult and youth grow up (NIHFW, 2005).

In India, the status of girl child reflects serious gender based difference, inequalities and

discrimination. Preference for son in the society and discrimination against girl child are interlinked. Gender based discrimination against female children is pervasive across the world. It is seen in all the strata of society and manifests in various forms. A girl's discrimination begins even before birth; a girl faces deprivation throughout her life. Preference for sons is obvious from the brutal traditions that are prevalent in India. Sex segregated norms are practiced among all sections, irrespective of class caste, class and ethnic communities, and this is common in rural as well as urban areas. In rural areas, there is marginalization of girl child's work and feminization of her labor. Girls are confined in homes to do household work and are trained for future married life and child rearing. They spend most of time in performing household chores, helping in farm work, looking after siblings etc.

In the rural community across Punjab, the modes of agricultural production have certainly changed but this has not resulted in significant changes at the cultural level. The position of the girl child cannot be looked at in isolation. Her status is a product of the general societal attitudes towards women at large. Women face higher risks of malnutrition, disease, disability, retardation of growth and development. They have no access of control over resources. Their work is invisible and hence undervalued. All their disabilities are powerfully reinforced through our culture, media, education and socialization process. The society in Punjab today with its rigid social structure is Patriarchal, where the social system controls women in such a way that she has no other choice but to surrender her to patriarchal values. Just for the sake of survival she has to sacrifice willingly or willingly her legitimate rights. Her voice is not heard; it is suppressed at home and community. If she pulls up enough courage to speak out, she is not considered normal women. Instead she is regarded as a male character and her moral life is suspected too.

Healthy family relationships, parental involvement and sound peer relationships are significant contributors to development of positive body image, achieving social maturity, emotional balance and eventually developing a high self-esteem in adolescent girls (Lenn & Green, 2000).

Control over resources and ideology are so inseparable and integratedly linked together that the loss of control over them leads to spiral with more and more powerless and helplessness within an individual and so within a group of individuals. In this manner the resources such as capacity to make individual decisions and opportunities to take part in community life for women in general and rural women in particular are limited. Being citizens of independent

country social change is very necessary which can empower the females. In this direction the pro ject AICRP (Home Science) child development component on 'Empowerment of rural adolescent girls for quality of life' is deemed to be appropriate with a holistic picture of girl child around the country.

Several studies have been conducted in India on adolescents. But there is rarely any study specifically focusing on the enhancing level of self esteem among rural adolescent girls. Therefore, the purpose of this study was to find out the levels of self-esteem of rural adolescent girls in their rural setting. This study also endeavors to find the effect of various socio-economic factors on the levels of self esteem scores, so rural adolescent girl could meet contemporary challenges of adolescent year without depending on others.

Methodology

The study was conducted on the self-esteem of rural adolescent girls Five villages namely: Hassanpur Gahaur Bahanur Mansuran and Mohie in district Ludhiana, Punjab state were selected purposively. The girl students enrolled in 10^{th}, 11^{th} and 12^{th} classes in each school were included in the sample of the study. The total sample comprised 153 girl students. The girls were selected from government schools located within the villages and permission was taken from the principals of the schools for conducting the study. The self-esteem tools was used for the collection of the data. The preliminary survey proforma was used to utilized for procure the general information of – name, age, caste, family type, family size, ordinal position, caste, education and occupation of parents, income, etc. A self structured self esteem scale was utilized for the data collection and to know the level of self-esteem of girls.

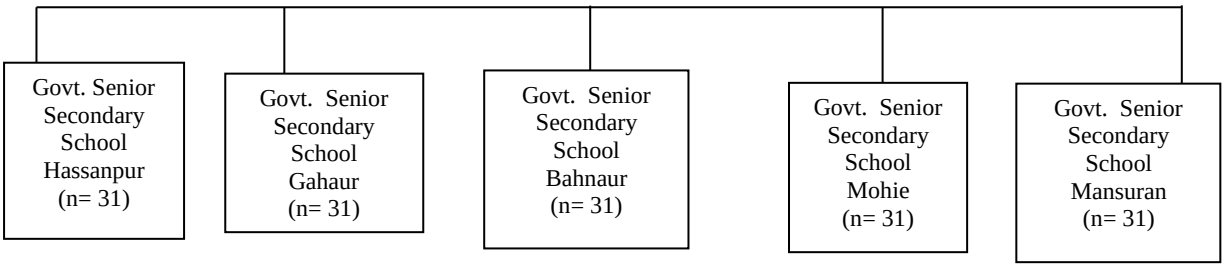
Tools/ Scales used: The self esteem tool was utilized for the data collection. The tool was categorized as:

Category	**Score**
Low	1-42
Medium	43-106
High	> 107

Selection: The sample for the present study constituted rural adolescent school going girls. The principals of government high schools in above said villages were contacted and briefed about the objectives of data collection and intervention program. The girl students enrolled in 10th

and 11th and 12th classes in each school were included in the sample of the study. The total sample comprised 153 girl students as shown in fig.

Rural Adolescent School Girls



The girl students were pretested for their self esteem and after 6 months post testing I was done. Six month period was given for intervention inputs such as lectures, demonstrations, group discussion to the girls to improve upon their self esteem and be confident in their decisions. Simultaneously post test 2, 3, 4 were done with six month intervention period in each post test.

Results and Discussion:

Self -Esteem of respondents of village Hassanpur:

N= 153, n= 31

Self -Esteem	**Pre test**	**Post test-1**	**Post test-2**	**Post test-3**	**Post test-4**
	n %	n %	n %	n %	n %
Low(10-20)	-	-	-	-	-
Medium (21-56)	20 64.52	19 61.29	18 58.06	14 45.16	6 19.35
High (31 and above)	11 35.48	12 38.71	13 41.94	17 54.84	25 80.60

Table explains that the self- esteem of the respondents of village Hassanpur. Self – esteem was measured as being self confident, socializing with other people, positive view of life. It was observed that with successive post testing the respondents shifted from medium to high category. At post test IV nearly 81% of the respondents from pretest to posttest IV fell in high category. The girls were helped to be confident and have a good personality with number of attempts and various methods.

Self -Esteem of respondents of village Gahaur:

N= 153, n= 31

Self -Esteem	**Pre test**	**Post test-1**	**Post test-2**	**Post test-3**	**Post test-4**
	n %	n %	n %	n %	n %
Low(10-20)	-	-	-	-	-
Medium (21-56)	22 71	20 65	18 58	14 45	6 19
High (31 and above)	9 29	11 35	13 42	17 55	25 81

Table describes the self- esteem of respondents of village Bhanaur. Almost similar results were observed as for village Hassanpur. Respondents shifted from medium to high level from pretest to posttest IV. At The end of posttest IV 81% of the respondents fell in high category. Sixteen respondents from pretest to posttest IV fell in high category.

Self -Esteem of respondents of village Bahanur:

N= 153, n= 31

Self -Esteem	**Pre test**	**Post test-1**	**Post test-2**	**Post test-3**	**Post test-4**
	n %	n %	n %	n %	n %
Low(10-20)	-	-	-	-	-
Medium (21-56)	21 68	18 58	16 52	14 45	1 3
High (31 and above)	10 32	13 42	15 48	17 55	30 97

Table elaborates on the self-esteem of respondents of village Gahaur. It was observed that during pretest 68% of the respondents fell in medium category and 32% in high category, posttest 1 58% fell in medium category. During posttest 3, 45 fell in medium category and 55% fell in high category whereas during posttest IV 3% fell in medium category and 97% fell in high category.

Self -Esteem of respondents of village Mohie:

N= 153, n= 31

Self -Esteem	**Pre test**	**Post test-1**	**Post test-2**	**Post test-3**	**Post test-4**
	n %	n %	n %	n %	n %
Low(10-20)	-	-	-	-	-
Medium (21-56)	21 68	18 58	16 52	14 45	1 3.22
High (31 and above)	10 32	13 42	15 48	17 55	30 96

Table depicts that the status of self- esteem of respondents of village Mohie. Almost similar status as for Gahaur was observed in village Mohie. At the end of posttest 4.96 % of respondents fell in high category. The status of self-esteem of the respondents improved as a result of interventions provided to the respondents.

Conclusion:

Thus the study reflects rural adolescent girls to know about their level of self esteem and it was found that the girl showed medium level of self esteem. Hence, **n**eed based intervention was imparted to enhance their self esteem. Post intervention results indicated that Intervention helped in improving their self esteem as all the girls fell in the higher category in the following aspects like getting things they desired, confident about decision making, having more of success than failure, acceptance by people and successful at handling social interactions etc. The girls were helped to be confident and have a good personality with number of attempts and various methods. It also highlights the factors that affect self-esteem during adolescent years. Gender perceptions are built during childhood and adolescence depending mainly on prevailing socio-cultural practices, which leads to lower self esteem among rural adolescent girls and they become used to the neglect and tolerate discrimination and justice.

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Formulation and Evaluation of Herbal Cream using Methanolic Extract of *Azadirachta indica*

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ABSTRACT

Various types of cream is considered for wound healing but these are still appears to be limited in rate of tissue regeneration**.** Plants are more potent healers because they promote the repair mechanism in the natural way. In this study, skin cream was prepared using *Azadirachta indica* leaves extract. Various formulations were prepared by varying the amount of excipients such as stearic acid, bees wax, stearyl alcohol, tween-80, methyl paraben, sorbitol solution, potassium hydroxide, deionised water etc. Formulation of Herbal Skin Cream using methanolic neem extract was successfully developed that met the relevant pharmaceutical characteristics. The prepared formulations are then evaluated for parameters like physical properties, pH, viscosity, spread ability and stability of the formulated cream. The prepared formulations showed good spreadability, no evidence of phase separation and good consistency during the study period. Stability parameters like visual appearance, nature, viscosity and pH of the formulations showed that there was no significant variation during the study period. The prepared formulations showed proper pH range that is approximately pH 6; it confirms the compatibility of the formulations with skin secretions. The creams were found to be stable during stability study according to ICH guidelines (40 ± 2 °C/ 75 ± 5 % RH) for 3 months.

Keywords: *Azadirachta indica*, Herbal Cream, Formulation and Evaluation

Introduction:

Cosmetic products are used to protect skin against exogenous and endogenous harmful agents and improve the beauty and attractiveness of skin. Cosmetics are not only developing an attractive external appearance, but towards achieving long life of good health by reducing skin disorders. The herbal ingredients present in skin care products that supports the strength to the skin, integrity of skin and texture, moisturizing, maintaining elasticity of skin by reduction of collagen and photo protection etc. This character of cosmetic is due to presence of ingredients in skin care formulation, because it helps to reduce the production of free radicals in skin and manage the skin properties for long time. The cosmetic products are the best choice to reduce skin disorders such as skin aging, skin wrinkling, hyper pigmentation and rough skin texture etc. The usage of synthetic products becomes very harmful from long time for the youth as well as

our environment (1,5,6). Various synthetic compounds, chemicals, dye and their derivative proved to cause various skin diseases having numerous side effects. The value of herbs in the cosmeceutical making has been extensively improved in personal care system and there is a great demand for the herbal cosmetics (2). Thus, we are using herbal cosmetics as much as possible. The basic idea of skin care cosmetic lies deep in the Rigveda, Yajurveda, Ayurveda, Unani and Homeopathic system of medicine. These are the products in which herbs are used in crude or extract form. These herbs should have varieties of properties like antioxidant, anti-inflammatory, antiseptic, emollient, anti-seborrheics, anti-kerolytic activity and antibacterial etc. The word herbal is a symbol of safety in contrast to the synthetic one which has adverse effects on human health (3,4).

Azadirachta indica (Neem)

- **Botanical Name**: *Azadirachta indica*
- **Common Name**: Marathi-Kadu Limba, Hindi-Neem, Tamil-Vepu
- **Popular Name**: Indian Lilac, Margosa Tree.
- **Parts Used**: Leaves, Flower, Oil, Seed
- **Taxonomic hierarchy**:

Kingdom: Plantae

Division: Magnoliophyta

Order: Sapindales

Family: Meliaceae

Genus: Azadirachta

Species: *A. indica*

Products made from neem trees have been used in India for over two millennia for their medicinal properties. Neem products are believed by Siddha and Ayurvedic practitioners to be anthelmintic, antifungal, antidiabetic, antibacterial, antiviral, contraceptive, and sedative. It is considered a major component in siddha medicine and Ayurvedic and Unani medicine and is particularly prescribed for skin diseases. Neem oil is also used for healthy hair, to improve liver function, detoxify the blood, and balance blood sugar levels. Neem leaves have also been used to treat skin diseases like eczema, psoriasis, etc (7,8).

Neem oil contains margosic acid, glycerides of fatty acids, butyric acid and trace of valeric acid. Various active principles are nimbidin, nimbidal, azardirachtin, nimbin, azadirine, gedunin,

salanin. They have diverse medicinal activities.

Neem oil is especially beneficial for curing skin ailments. Oil is used for dressing for foot ulcers, eczema and skin diseases like ringworm, scabies and mange in dogs. It is a powerful insect repellant, anti-bacterial, anti-fungal, anti-viral, anti-inflammatory and also strengthens the body's overall immune responses. Neem oil contains fatty acids which build collagen, promote wound healing and maintain the skin's elasticity. (9,10)The active ingredients of neem oil help in the process of wound healing and the skin is able to retain its suppleness as the wounds heal. Neem oil has a high content of essential fatty acids. They keep the site moist and give a soft texture to the skin during the healing process. Alcoholic extract of neem is useful in eczema, ringworm and scabies. Neem leaf extracts and oil from seeds has proven anti-microbial effect. This keeps any wound or lesion free from secondary infections by microorganisms. Clinical studies have also revealed that neem inhibits inflammation as effectively as cortisone acetate, this effect further accelerates wound healing (11,12,13).

Materials and Methods:

Materials and Preparation of Extract: Table 1 shows the list of materials used during this study. Methanolic extract of *Azadirachta indica* were prepared by Soxhlet method (14).

Table 1: List of materials

S.no.	**Materials used***	**Sources**
1	Leaves of *Azadirachta indica*	SSCP Campus, MANAWALA
2	Stearic acid	Merck Lifesciences Pvt. Ltd. Mumbai
3	Liquid paraffin	Merck Lifesciences Pvt. Ltd. Mumbai
4	Bees wax	Merck Lifesciences Pvt. Ltd. Mumbai
5	Stearyl alcohol	Merck Lifesciences Pvt. Ltd. Mumbai
6	Methyl paraben	Merck Lifesciences Pvt. Ltd. Mumbai
7	Potassium hydroxide	Merck Lifesciences Pvt. Ltd. Mumbai
8	Tween 80	Merck Lifesciences Pvt. Ltd. Mumbai
9	Sorbitol solution	Merck Lifesciences Pvt. Ltd. Mumbai

Preliminary Phytochemical Investigation of Methanolic Extract of the Neem:

Preliminary phytochemical investigation of the methanolic extract of the plants is done by using TLC chromatogram**.**

Formulation and Evaluation of the Herbal Skin Cream:

Formulas for Preparation of Cream: Table 2 shows the formulas for preparations of creams (15).

Table 2: Formulations of cream.

Sr. no.	Ingredient	Formula 1 (%)	Formula 2 (%)	Formula3 (%)	Formula4 (%)	Formula5 (%)	Formula6 (%)
1	*A. indica* extract	5	5	5	5	5	5
2	Liquid paraffin	5	5	5	5	5	5
3	Stearic acid	3	3	5	5	4	5
4	Bees Wax	5	6	5	4	6	5
5	Stearyl alcohol	10	10	10	8	8	7
6	Tween-80	8	5	5	5	5	6
7	Methyl paraben	0.12	0.12	0.12	0.12	0.12	0.12
8	Sorbitol solution	6	6	5	5	5	5
9	Potassium hydroxide	5	5	5	5	5	5
10	De-ionized water	33	36	37	40	39	38

Evaluation of Skin Care Cream

Physical Evaluation of the Formulation: The formulations were inspected visually for their appearance, colour and odour.

Measurement of pH: pH was measured using a pH meter, which was calibrated before each use with standard buffer solutions at pH 4, 7, 9. The electrode was inserted into the sample 10 minutes prior to taking the reading at room temperature (16).

Viscosity: The viscosity of the formulations was checked using a Brookfield Viscometer. The gels were rotated at 0.3, 0.6, 1.5 rotations per minute. The viscosity of the gel was obtained by multiplying the corresponding dial reading with the factor given in the Brookfield Viscometer catalogue (17).

Spreadability: Spreadability is measured in terms of time in seconds taken by two slides to slip off from the gel when placed in between the slides under the direction of a certain load. The excess amount of sample was placed between the two glass slides and a definite amount of weight was placed on these glass slides to compress the glass slides of uniform thickness. A weight of 70 g was added and the time required to separate the two slides was noted. Spread ability was calculated using the formula (18).

$$S = M*L / T$$

where,

M = weighted to upper slide,

L = length of glass slides,

T = time taken to separate the slides.

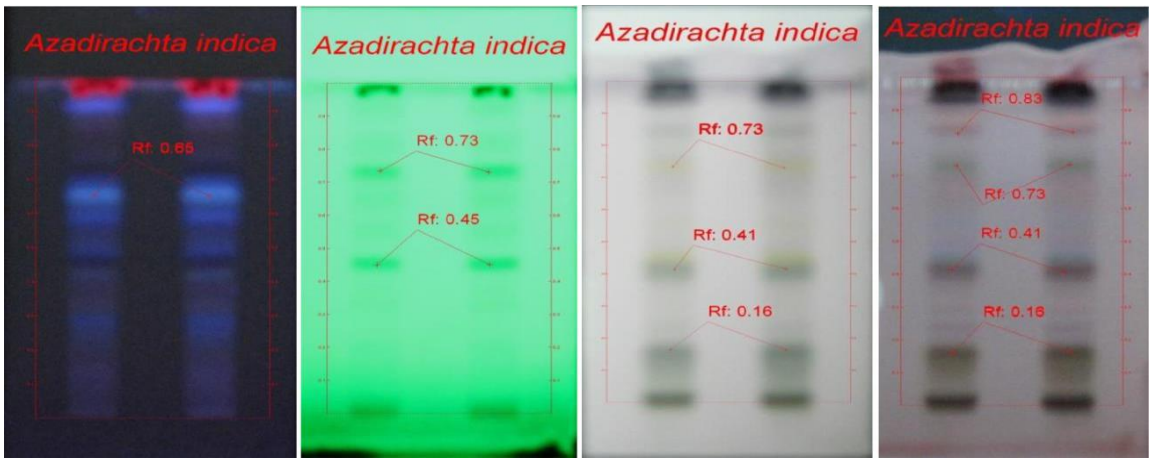
Stability: Stability testing of drug products begins as a part of drug discovery and ends with the demise of the compound or commercial product. To assess the drug and formulation stability, stability studies were done according to ICH guidelines. The stability studies were carried out as per ICH guidelines. The cream filled in bottle and kept in humidity chamber maintained at 40 ± 2°C / 75 ± 5 % RH for three months. At the end of studies, samples were analyzed for the physical properties, pH and viscosity (19).

Results and Discussions

Preliminary Phytochemical Investigation of Methanolic Extract of Plants:

TLC chromatogram of *Azadirachta indica*

- Mobile phase : Ethyl acetate: n-Butanol: Formic acid: Water (25:15:5:5)
- Tank saturation: 20 minutes
- Sample applied: 7µl & 9 µl
- Solvent front: 85mm
- Drying : 5minutes
- Detection/visualization: At 366nm, 254nm & after derivatization
- Derivatization: Anisaldehyde sulphuric acid



UV 366 nm UV 254 nm Under visible light UV 366 nm

Evaluation of Skin Care Cream

Physical Properties of Cream: All creams are semisolid in nature. Creams are yellowish in colour and have characteristic odour.

Thermal Stability of Cream (At room temperature and 65% ± 5% RH)**:** Formula 1 to 4 creams were stable at room temperature but formula 5 and 6 were showed slight oily separation.

pH of the Cream: pH of the cream shows in the table no. 3 which range from 5.89 to 6.11 of the different formulations. pH of creams is close to 6 which suitable for skin because pH of the skin is approximately 6.

Table 3: pH of the creams

Formula 1	Formula 2	Formula 3	Formula 4	Formula 5	Formula 6
6.05	5.89	6.11	6.02	5.97	5.94

Viscosity of the Cream: At 0.5 rpm to 1.5 rpm viscosity was decreased from 7342 to 1876 cps. So, if we decrease the rate of shear it increases the viscosity of cream. Viscosity of creams is inversely proportional to rate of shear (rpm) and the results are showed in table no. 4.

Table 4: Viscosity of the creams

rpm	Formula 1	Formula 2	Formula 3	Formula 4	Formula 5	Formula 6
0.3	7342	7413	7534	7241	7187	7216
0.6	3876	3906	3987	3456	3187	3296
1.5	1876	1893	1956	1785	1863	1816

Spreadability of the Cream: The spread ability of the formulations is showed in table 5. The spreadability ranges from 13.8 to 14.2.

Table 5: Spreadability of the creams

g.cm/sec	Formula 1	Formula 2	Formula 3	Formula 4	Formula 5	Formula 6
Spreadability	14.2	14.1	14.4	13.8	13.7	14.0

Accelerated Stability Studies of Cream: Accelerated stability testing of prepared formulations were conducted at 40° ± 2°C temperature and 75± 5% relative humidity and studied for 90 days. The creams formulations did not show any change in the physical characteristics, pH and viscosity in the stability studies which are shown in table no. 6 and 7. The creams were found to be stable during stability study according to ICH guidelines (40 ± 2 °C/ 75 ± 5 % RH) for 3 months.

Table 6: pH of the creams (Initial and after 3 months)

pH	Formula 1	Formula 2	Formula 3	Formula 4	Formula 5	Formula 6
Initial	6.05	5.89	6.11	6.02	5.97	5.94
After 3 months	6.02	5.91	6.11	5.98	5.97	5.91

Table 7: Viscosity of the cream (Initial and after 3 months)

rpm	Formula 1	Formula 2	Formula 3	Formula 4	Formula 5	Formula 6
Initial	1876	1893	1956	1785	1863	1816
After 3 months	1789	1810	1914	1721	1803	1765

Conclusion

The prepared formulation showed good spreadability, no evidence of phase separation and good consistency during the study period. From the above study, it can be concluded that it is possible to develop creams with herbal extracts. The methanolic extract of *Azadirachta indica* exhibited

strong antibacterial activity. The results of different tests of cream showed that the formation could be used topically in order to protect the skin against damage. Natural remedies are more acceptable in the belief that they are safer with fewer side effects than the synthetic ones. So, an herbal cream which is non-toxic, safe, effective and improves patient compliance by the utilization of herbal extracts would be highly acceptable. Further research will carry out to check scientifically the synergistic action of formulation.

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Yield, Content and Nutrients Uptake Affected by IPNS for Maize (*Zea Mays*) Crop Under Inceptisol of Bulandshahar (U.P.)

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ABSTRACT

A field experiment was conducted at Agricultural Research Farm of Amar Singh (P.G.) College, Lakhaoti, Bulandshahar to know response of IPNS on yield, nutrient content and uptake by maize crop. The grain yield (average of two year) ranged from 33.13 to 52.56 q ha^{-1}, strover yield 40.32 to 60.76 q ha^{-1} and total biological yield 73.44 to 113.32 q ha^{-1} where maximum yield of maize was produced by application of nutrients through 10 tonnes ha^{-1} FYM + Rest through chemical fertilizers **(**T_3**)**. Nutrient contents under integrated plant nutrient supply (IPNS) of maize crop was observed maximum 1.51, 0.45 and 0.59 percent NPK respectively, in grain and 0.98, 0.705 and 1.80 percent NPK respectively, in stover through application of nutrients by 10 tonnes ha^{-1} FYM + Rest through chemical fertilizers (T_3). Similarly, in case of nutrients uptake by maize crop was found maximum 79.37, 23.66 and 30.74 kg ha^{-1} NPK respectively through grains while 59.24, 42.83 and 109.37 kg ha^{-1} NPK respectively, through stover of maize crop under treatment T_3 (10 tonnes ha^{-1} FYM + Rest through chemical fertilizers). In these parameters, significant increase was recorded in the treatments received organic, inorganic and bio-fertilizer sources of nutrients in combined form.

Key words: IPNS, chemical fertilizers, bio-fertilizers, maize, content, uptake.

Introduction

Maize (*Zea mays* L.), as a source of carbohydrate is well known crop grown in kharif season in India. Maize is one of the most important cereal crops in India. With the introduction of improved varieties and improved techniques to grow maize particularly the hybrids/composites, a wider spacing is recommended for it. Thus, there is ample scope to utilize the vacant inter-row space of maize by introducing some compatible crops **(Singh and Singh, 1993)**. Intercropping with legumes may maintain the system in a positive nitrogen balance and if there is good growth of legumes, the nitrogen contribution can be significant. **Shivay *et. al.* (2001)** observed significantly higher 1000 grain weight of maize under urd-bean and soybean intercropping than sole maize. Thus, for higher productivity and improvement in soil fertility for longer period, integrated plant nutrient management system (IPNS) has become important. The principal aim of IPNS is efficient and judicious use of all the major sources of plant nutrients in an integrated manner, so as to get maximum economic yield without any deleterious effects on physico-chemical and biological properties of the soil.

Materials & Methods

An experiment was conducted during the kharif season at the Agricultural Research Farm of Amar Singh (P.G.) College, Lakhaoti (Bulandshahar). The Research Farm is situated about 15 km away from Bulandshahr on Bulandshahr-Garh road. Bulandshahr, located in western Uttar Pradesh, is the most fertile and suitable belt of Doab of Ganga and Yamuna for cereals and vegetables. It lies between 28^0 N latitude and 77' E longitude at an elevation of about 201.48 m above mean sea level. The average annual rainfall of this region is 703.75 mm. About 88% of rainfall is received from June to September and the remaining (20%) during October to March. May and June are the hottest months of the year and maximum temperature ranges between 43-45^0C while January is the coldest month with minimum temperature ranging between 3-6^0C. Treatments description are $\mathbf{T_1}$: Recommended dose of NPK (120: 60:40), $\mathbf{T_2}$: Fertilizer dose based on soil test value, $\mathbf{T_3}$: 10 tonnes ha^{-1} FYM + Rest through chemical fertilizers, $\mathbf{T_4}$: Azotobacter + 75% N and full dose of P & K through chemical fertilizers, $\mathbf{T_5}$: Rhizobium + 50% P and full dose of N & K through chemical fertilizers, $\mathbf{T_6}$: PSB (Phosphorus solubilizing bacteria) + 75% P and full dose of N & K through chemical fertilizers, $\mathbf{T_7}$: *Azotobacter* + *Rhizobium* + PSB + 75% N, 25% P and 100% K through chemical fertilizers, $\mathbf{T_8}$: *Azotobacter* + *Rhizobium* + PSB + 10 t ha^{-1} FYM and 33% N, no P and K through chemical fertilizers, $\mathbf{T_9}$: 2 t ha^{-1} Vermicompost + 75% Recommended dose of NPK. Fertilizers namely Urea (46% N), DAP (48% P) and MOP (60% KCl) were used as a source of nitrogen, phosphorus and potassium respectively, in the form of chemical fertilizers. FYM was also used as a source of nitrogen, phosphorus, potassium and mirco-elements in the form of organic manure. The microbial culture of *Azotobacter (A. chroococcum)*, PSB *(Bacillius* and *Pseudomonas*) & *Rhizobium* were used as bio-fertilizers.

All the cobs of each plot were weighed and multiplied with the shelling percentage and fixed the yield on 15 percent moisture by factor. The grain yield was calculated by the formula given below:

$$\text{Grain yield (kg / net plot)} = \frac{\text{Fresh Weight of cob (100 – moisture\%) x shelling\% x 1.176}}{100}$$

This grain yield was converted by multiplying the factor and reported as grain yield of q ha^{-1}. After removal of cobs from the stalks manually, remaining produce weight was recorded and reported as q ha^{-1}. After removal of cobs from the stalks manually remaining produce weight

was recorded and reported as q ha^{-1}. The biological yield was presented by produce (grain + straw) of each net plot was allowed to air dry in the field after harvesting and weighed and reported as biomass of net plot in q ha^{-1}. Nitrogen was determined by micro Kjeldhal method **(Jackson, 1958)**. The Kjeltec auto analyzer was used for analysis. It was expressed in percentage on dry weight basis. Phosphorus content in digested plant samples was determined by vanado molybdate phosphoric acid and readings were read at spectrophotometer at 470 wavelength as described by Champman and Parker (1961). Potassium content of plant samples was determined by flame photometer (mediflame) at 786 µm **(Jackson, 1958)**. The data was tabulated and processed to suit for computerization and analysis of variance, by method as given by **Snedecor and Cochran (1968)**.

Result and Discussion

Yield

Highest grain yield of maize (51.74 q/ha during 1^{st} year and 53.38 q/ha during 2^{nd} year) was recorded from the treatment T_3 (FYM + Chemical fertilizer). In this treatment grain yield was recorded significant higher over rest of the treatment during both the years. Maize yield was recorded lowest (31.14 q/ha during 1^{st} year and 35.11 q/ha during 2^{nd} year) in the treatment T_9 (Vermicompost + Chemical fertilizer). T_3 registered 58.6 per cent higher yield over T_9 in average data of both the years. In general, mean grain yield of maize increased with increasing substitution of NPK nutrients by FYM, bio-fertilizers such as *Azotobacter, Rhizobium* and PSB over chemical fertilizer alone. In support of this **Mustafa *et.al.* (2008)** found that the 100% recommended dose of N and P + Rhizobium + PSB has resulted in higher growth, yield attributes and yield of chickpea. Substantial increase in grain yield of maize due to application of

Table 1 : Effect of integrated plant nutrient supply on grain yield, stover yield and total biological yield of maize crop.

Treatments	Grain yield (q/ha)			Stover yield (q/ha)			Total biological yield (q/ha)		
	2004	2005	Average	2004	2005	Average	2004	2005	Average
T_1	34.84	38.54	36.69	41.97	46.48	44.23	76.81	85.02	80.92
T_2	38.76	40.30	39.53	46.46	48.31	47.39	85.22	88.61	86.92
T_3	51.74	53.38	52.56	60.10	61.42	60.76	111.84	114.80	113.32
T_4	44.84	43.24	44.04	53.46	52.03	52.75	98.30	95.27	96.79
T_5	32.23	38.39	35.31	38.79	46.16	42.48	71.02	84.55	77.79
T_6	35.19	39.55	37.37	42.43	47.15	44.79	77.62	86.70	82.16
T_7	39.06	41.21	40.14	46.33	48.42	47.38	85.39	89.63	87.51
T_8	45.15	45.22	45.19	49.60	52.63	51.12	94.75	97.85	96.30
T_9	31.14	35.11	33.13	37.75	42.88	40.32	68.89	77.99	73.44
S.Em.±	1.97	1.98	1.18	1.56	1.94	1.28	3.83	3.81	2.42
CD (0.05)	5.91	5.94	3.86	4.68	5.82	4.20	11.49	11.43	7.90

T_1: Recommended dose of NPK (120: 60:40), **T_2** : Fertilizer dose based on soil test value, **T_3** : 10 tonnes ha^{-1} FYM + Rest through chemical fertilizers, **T_4** : Azotobacter + 75% N and full dose of P & K through chemical fertilizers, **T_5** : Rhizobium + 50% P and full dose of N & K through chemical fertilizers, **T_6** : PSB (Phosphorus solubilizing bacteria) + 75% P and full dose of N & K through chemical fertilizers, **T_7** : *Azotobacter* + *Rhizobium* + PSB + 75% N, 25% P and 100% K through chemical fertilizers, **T_8** : *Azotobacter* + *Rhizobium* + PSB + 10 t ha^{-1} FYM and 33% N, no P and K through chemical fertilizers, **T_9** : 2 t ha^{-1} Vermicompost + 75% Recommended dose of NPK.

FYM was also advocated by **Cremenescu *et al.* (1989)**. Combined use of *Azotobacter* + *Rhizobium* + PSB + FYM + Chem. (T_8) improved the crop yield markedly. This was primarily attributed to production of cytokinin in the *Rhizobium* by *Azotobacter*. Plant cytokinins are produced primarily in the roots and translocated via xylem to the shoots, which used to stimulate cell division and thus increase the yields **(Alagawadi and Gaur, 1988). Rudesh *et al*. (2005)** suggested that combined inoculation of rhizobium, PSB and *Trichoderma* spp.

Data given in Table 1 revealed that strover yield was highest in T_3 (FYM + chemical fertilizer) which was recorded significantly superior over rest of the treatments during both the years. Whereas, T_9 produced the least strover yield (37.75 q ha^{-1} in 1^{st} year and 42.80 q ha^{-1} in 2^{nd} year). **Singh *et.al.* (2006)** supported and reported that on application of Rhizobium and VAM resulted in the highest number of pods/plant (25.2)), seed yield per plant (6.9 g), test weight (151.7 g), seed yield (15.7), straw yield (5.56) and protein content (22.0%) in Chickpea.

Biological yield differenced significantly due to various treatments during both the years of study as well as in average values. It was recorded that biological yield was highest in T_3 (111.84 q ha^{-1} in 1^{st} year and 114.80 q ha^{-1} in 2^{nd} year) resulted in significantly higher than rest of the treatments during both the years and in average values also. While the minimum yield was obtained through application of 2 t ha^{-1} Vermicompost + 75% Recommended dose of NPK.(T_9) in both the years of investigation (68.89 ha^{-1} in 1^{st} year and 77.99 ha^{-1} in 2^{nd} year). In general, mean grain yield, strover yield, biological yield of maize increased with increasing substitution of NPK nutrient by FYM and bio-fertilizers such as *Azotobacter, Rhizobium* and PSB. showed increased NPKS uptake, plant height, number of branches, yield and total biomass in chickpea over un-inoculated control.

Content and Uptake

Nitrogen

Differences in nitrogen content in maize grain and stover as well as its uptake due to IPNS treatments were found significant during both the years and in average values. Integrated use of Azoto + Rhizobium + PSB + FYM + Chemical fertilizer (T_8) and Azoto + Chemical fertilizer (T_4) recorded statistically similar N content in grain and stover of maize during both the years and in their average values also. These treatments showed significant superiority to other remaining treatments. While the minimum values of N content was found with T_9

(Vermicompost + Chemical fertilizer 1.29% in grain and 0.68% in stover in 2004 and 1.30% grain and 0.68% in stover in 2005).

As regards to N uptake in grains and stover, T_3 showed significantly higher N uptake (77.61 kg ha^{-1} in grain and 58.30 kg ha^{-1} in stover in 2004 and 81.14 kg ha^{-1} in grain and 60.19 kg ha^{-1} in stover in 2005) than rest of the treatments in both the years of experimentation and in their average values also. The minimum average value (grain 42.91 kg ha^{-1} and stover 27.41 kg ha^{-1}) of N uptake was obtained in T_9 treatment.

Phosphorus

Phosphorus content in both grain and stover obtained from T_3 treated plot values 0.45 per cent and T_3 and T_8 treated plot value 0.705 per cent, respectively in average were found significantly higher over remaining treatments. Similar trend was also observed with uptake in both grain and stover of maize during both the years and it there average values also. As regards to P uptake in grains and stover, T_3 showed significantly higher P uptake (22.77 kg ha^{-1} grain and 42.67 kg ha^{-1} in stover in 2004 and 24.55 and 42.99 kg ha^{-1} in 2005).

Potassium

Variations in potassium content and uptake in maize grain and stover due to various IPNS treatments were found significant higher values of 0.59% and 1.80% potassium in grain and stover, respectively on the basis of average data were associated with T_3 (FYM + Chemical fertilizer). However, markedly higher K uptake in stover was associated with T_3 (table-2). The minimum value was obtained under T_9 (60.88 kg ha^{-1} in average values). N, P and K content as well as their uptake by maize were maximum under integrated use of FYM + Chem. fertilizer (T_3) which was *at par* with treatment T_8 (*Azoto* + *Rhizobium* + PSB + FYM + Chem.) and T_4 (*Azoto* + *Chem.*). These treatments showed significant superiority over the other remaining treatments. This might be due to increased supply of nutrients directly through organic (FYM, PSB, *Azotobacter* & *Rhizobium*) and inorganic sources to the crop as well as indirectly through checking the loss of nutrients (N, P and K) from soil solution which is turn resulted in better growth (Table 2), higher biological yield as well as more nutrient concentration in treatment T_3 (Table 2).

Table 2: Nitrogen, Phosphorus and Potassium content and uptake (average of two years) by grain and stover of maize as influenced by integrated plant nutrient supply

Treatments	Content (%)						uptake (kg ha^{-1})					
	Nitrogen		Phosphorus		Potassium		Nitrogen		Phosphorus		Potassium	
	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover
T_1	1.32	0.75	0.35	0.405	0.54	1.55	48.26	32.94	13.40	17.92	19.81	68.55
T_2	1.39	0.77	0.39	0.405	0.57	1.57	54.95	36.25	15.61	19.19	22.34	74.39
T_3	1.51	0.98	0.45	0.705	0.59	1.80	79.37	59.24	23.66	42.83	30.74	109.37
T_4	1.41	0.85	0.36	0.570	0.53	1.74	61.87	44.83	16.08	30.06	23.37	91.78
T_5	1.33	0.71	0.30	0.500	0.51	1.54	46.96	30.19	11.78	21.24	18.04	65.41
T_6	1.34	0.73	0.32	0.505	0.54	1.58	50.08	32.48	11.96	22.61	20.03	70.77
T_7	1.38	0.84	0.38	0.605	0.55	1.60	55.20	39.56	15.46	28.67	22.07	75.80
T_8	1.44	0.89	0.41	0.705	0.58	1.77	64.84	45.49	18.75	36.04	25.98	90.47
T_9	1.30	0.68	0.31	0.510	0.50	1.51	42.91	27.41	10.44	20.59	16.56	60.88
S.Em.±	0.0056	0.0048	0.006	0.00081	0.012	0.00039	1.94	0.51	0.18	0.77	0.34	0.95
CD (0.05)	0.018	0.015	0.019	0.0026	0.042	0.0012	6.34	1.67	0.54	2.28	1.07	3.93

T_1: Recommended dose of NPK (120: 60:40), **T_2** : Fertilizer dose based on soil test value, **T_3** : 10 tonnes ha^{-1} FYM + Rest through chemical fertilizers, **T_4** : Azotobacter + 75% N and full dose of P & K through chemical fertilizers, **T_5** : Rhizobium + 50% P and full dose of N & K through chemical fertilizers, **T_6** : PSB (Phosphorus solubilizing bacteria) + 75% P and full dose of N & K through chemical fertilizers, **T_7** : *Azotobacter* + *Rhizobium* + PSB + 75% N, 25% P and 100% K through chemical fertilizers, **T_8** : *Azotobacter* + *Rhizobium* + PSB + 10 t ha^{-1} FYM and 33% N, no P and K through chemical fertilizers, **T_9** : 2 t ha^{-1} Vermicompost + 75% Recommended dose of NPK.

Increased uptake of N, P and K by maize is due to *Azotobacter* inoculation **(Sikilar, 1974)**, application of FYM **(Meshram and Shinde, 1982)**; PSB **(Alagawadia and Gaur, 1988; Jisha and Alagawadia, 1996; Patil, 1997)** and *Rhizobium* **(Sreenivasa, 1992, and Prathiba, 1994)** have also been reported earlier.

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Constraints and Socio-Economic Viability among Direct Seeded Rice growing Farmers of Haryana

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ABSTRACT

Rice, the staple food of more than half of the population of the world, is an important target to provide food security and livelihoods for millions. Imminent water crisis, water-demanding nature of traditionally cultivated rice and climbing labour costs ramble the search for alternative management methods to increase water productivity, system sustainability and profitability. Direct seeded rice (DSR) technique is becoming popular now a day because of its low-input demanding nature. It offers a very exciting opportunity to improve water and environmental sustainability. It involves sowing pre-germinated seeds into a puddled soil surface (wet seeding), standing water (water seeding) or dry seeding into a prepared seedbed (dry seeding). However, weed and nematode infestation are major problems, which can cause large yield losses in DSR. Other associated problems with DSR are increased incidences of blast disease crop lodging impaired kernel quality, increased panicle sterility and stagnant yields across the years. Based on the existing evidence, the present paper highlights the socio-economic impact of DSR, and problems associated with DSR. The study was conducted in Kurukshetra district of Haryana state. From this district, two blocks namely Thanesar and Pehowa were selected randomly.The data presented that constraints regarding marketing, technical guidance, financial constraints and miscellaneous constraints perceived by respondents were lack of marketing facilities in village, non-availability of extension officials for technical guidance, hesitation in investing money on DSR cultivation, depression is felt due to paddy appearance of direct seeded rice is not good in the first two months, ranked first constraint, respectively.

Key words: Direct seeded rice, marketing facilities, socio-economic impact, constraints

Introduction

Rice, the staple food of more than half of the population of the world, is an important objective to provide food security and livelihoods for millions. Imminent water crisis, water-demanding nature of traditionally cultivated rice and climbing labour costs ramble the search for alternative management methods to increase water productivity, system sustainability and profitability. Direct seeding has been advocated as an alternative to transplanting as it allows more rapidly land preparation and saves approximately 20 percent of labor cost and 30 percent of water cost during crop establishment (Lee et al. 2002; Swiss Agency for Development and Cooperation (SDC 2008). Direct seeding of rice is gaining popularity among farmers in Asia in response to these productivity constraints (Johnson et al. 2003). Labor scarcity has also led to the spread of direct seeding in India (Hobbs et al. 2002,Balasubramanian and Hill (2002)

emphasized that, despite the reductions in labor and associated costs for crop establishment, however, other technologies are essential to overcoming constraints such as lodging of the mature rice crop imposed by direct seeding.

Direct seeded rice (DSR) technique is becoming popular now a days because of its low-input demanding nature. It offers a very exciting opportunity to improve water and environmental sustainability. According to Pandey and Velasco (2005), l ow wages and adequate availability of water favor transplanting, whereas high wages and low water availability favor DSR. The development of short duration, early-maturing cultivars and efficient nutrient management techniques along with increased adoption of integrated weed management methods haveencouraged many farmers to switch from transplanted to DSR culture. This technology is highly mechanized in some developed nations like U.S, Europe and Australia. This shift should substantially reduce crop water requirements and emission of greenhouse gases. The reduced emission of these gases helps in climate change adaptation and mitigation, enhanced nutrient relations, organic matter turnovers, carbon sequestration and also provides the opportunity of crop intensification. However, weed and nematode infestation are major problems, which can cause large yield losses in DSR. Other associated problems with DSR are increased incidences of blast diseasecrop lodging impaired kernel quality, increased panicle sterilityand stagnant yields across the years.Based on the existing evidence, the present paper highlights the socio-economic impact of DSR, and problems associated with DSR, and suggest likely future patterns of changes in rice cultivation.

Methodology

The study was conducted in Kurukshetra district of Haryana state. From this district, two blocks namely Thanesar and Pehowa were selected randomly. Further, Amin, Alampur, Bachgaon, Dodakheri, Balani, Bir Amin, Issargarh, GhamoorKheeri, JivenKheri, Jyotisar, Kamoda, Kisangarh, Lukhi, Muthana, Ghararsi, Barana, Mirjapur, Pindarasi, Sirsana and Umri villages were selected from Thanesar block. Talhari, Chandanheri, Ishaq, Bilochpura, MeghaMajra, JurasiKalan, Shahpur, Sainsa, SainaSaida, Malikpur, Karan Shahab, Gumthala, Thana, Neemwala and Kakrali villages were selected from Pehowa block. Hundred rice direct seeded rice growing farmers were selected. Interview Schedule was prepared as per objectives of the study. Farmers were surveyed with the help of Interview Schedule. The data thus, collected were computed, tabulated and analyzed using frequency, percentage, mean score, and rank.

Results

Constraints related to technical guidance perceived by farmers

Regarding the constraints related to technical guidance (Table 1) 54 percent of the respondents opinioned a serious problem related to non-availability of extension officials for technical guidance(rank I) with highest weighted mean score (2.37), followed by 'Lack of guidance about recommended doses of new weedicides and their application techniques' which ranked second with weighted mean score 2.21, 'lack of knowledge of current advances in direct-seeded rice cultivation technology' as third major constraint with weighted mean score 2.20, whereas 'lack of guidance for proper sowing time' ranked fourth with weighted mean score (2.18), 'lack of guidance for controlling insect-pests & diseases and application of pesticides and fungicides' ranked fifth with weighted mean score (1.98) Fig. 1. The causes of lower yield in Wet- and Dry-DSR reported by researchers in different production zones may include (1) uneven or poor CE, (2) inadequate weed control (Johnson and Mortimer, 2005; Gathala et al., 2011).(3) Higher spikelet sterility than in puddled transplanting 2007; Chauhan et al. 2010).(4) Higher crop lodging, especially in wet seeding and broadcasting (Fukai, 2002, Ganwar, 2008). (5) Insufficient knowledge of water and nutrient management (Heaps 2010; Yadvinder- Singh et al., 2008; Sudhir-Yadav et al. 2011a, Bazaya 2009). Herbicide-resistant rice technologies offer

Table 1: Constraints related to technical guidance perceived by DSR farmers (n=100)

S. No.	Technical guidance constraints	Constraints			Total weighted score	Weighted mean score	Rank order
		Very serious (3)	Serious (2)	Not so serious (1)			
1.	Lack of guidance for proper sowing time	37	44	19	218	2.18	IV
2.	Lack of guidance for controlling insect-pests & diseases and application of pesticides and fungicides	31	36	33	198	1.98	V
3.	Non-availability of extension officials for technical guidance	54	29	17	237	2.37	I
4.	Lack of guidance about recommended doses of new weedicides and their application techniques	43	35	22	221	2.21	II
5.	Lack of knowledge of current advances in direct-seeded rice cultivation technology	48	24	28	220	2.20	III

opportunities for selective control of weedy rice but the risk of gene flow from herbicide-resistant rice to weedy rice poses a constraint for the long-term utility of this technology (Kumar et al., 2008a).

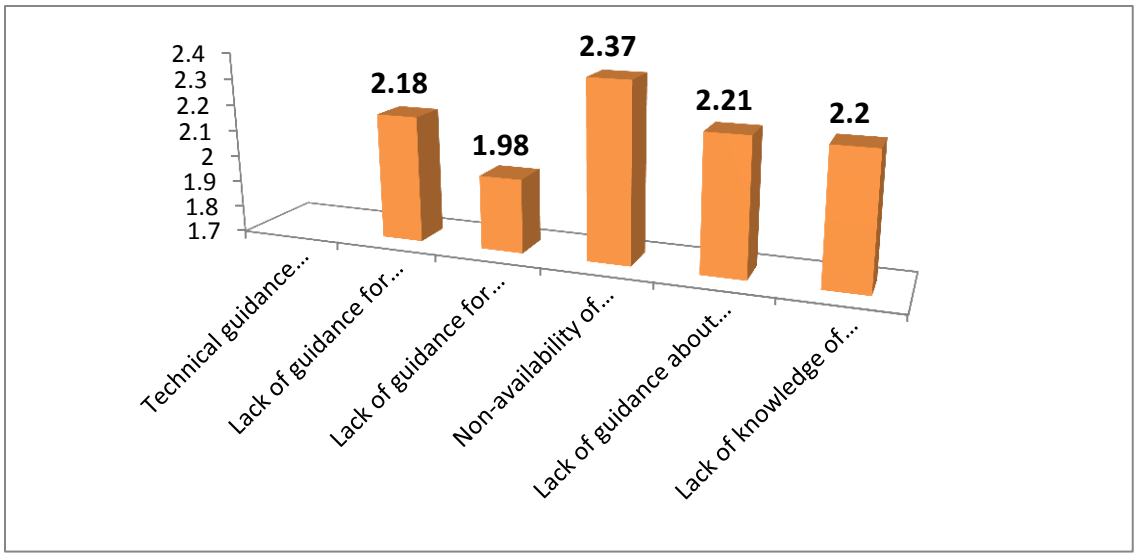

Fig. 1: Constraints related to technical guidance perceived by farmers

Financial constraints perceived by farmers

Regarding the financial constraints (Table 2) perceived by DSR growing farmers 63%

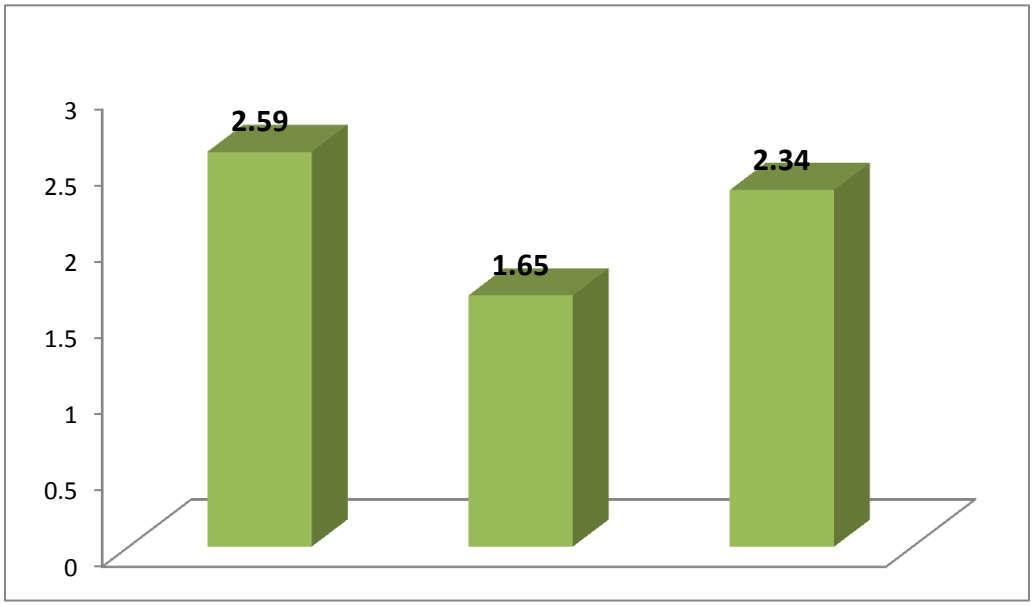

Fig.2: Financial constraints perceived by farmers

consider it very serious constraint and feel hesitation in investing money on DSR cultivation (ranked I with highest weighted mean score (2.59) followed by 'higher cost of farm machinery' and 'inadequate funds to buy seed drill, power sprayers, harvester and other farm implements' were ranked second and third constraints with weighted mean score 2.34, 1.65 respectively fig.

Table 2: Financial constraints perceived by DSR farmers

(n=100)

S. No.	Financial constraints	Constraints			Total weighted score	Weighted mean score	Rank order
		Very serious (3)	Serious (2)	Not so serious (1)			
1.	Hesitation in investing money on DSR cultivation	63	33	4	259	2.59	I
2.	Inadequate funds to buy seed drill, power sprayers, harvester and other farm implements	24	17	59	165	1.65	III
3.	Higher cost of farm machinery	57	20	23	234	2.34	II

Miscellaneous constraints

The data (Table 3) regarding perception about miscellaneous constraints perceived by

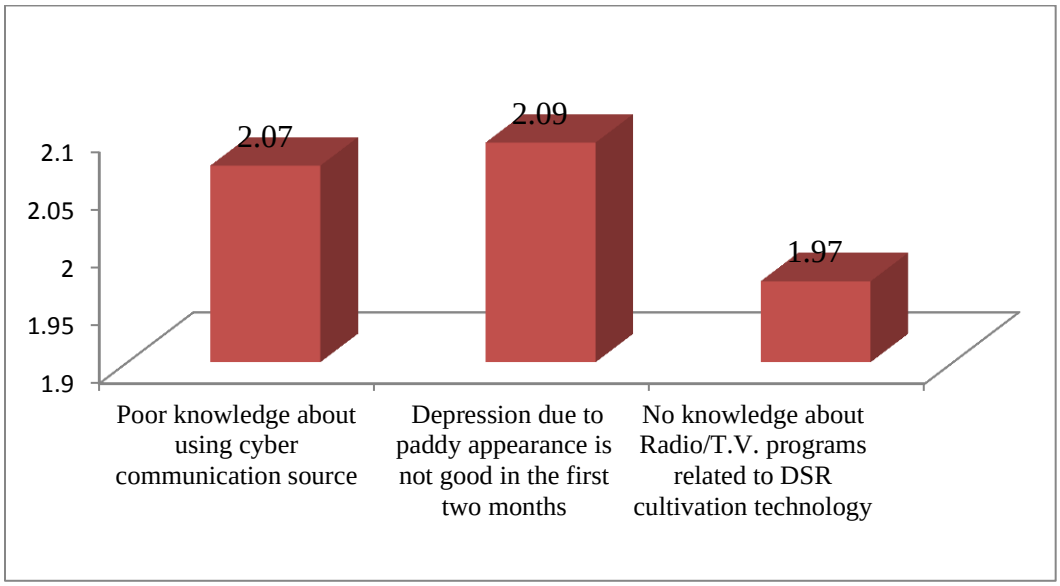

Fig. 3: Miscellaneous constraints

farmers reveals that depression is felt due to paddy appearance of direct seeded rice is not good in the first two months, ranked first with highest weighted mean score (2.09) followed by Poor knowledge about using cyber communication source and no knowledge about Radio/T.V. programs related to DSR cultivation technology were ranked second and third with weighted mean score 2.07 and 1.97 respectively fig. 3.

Table 3: Miscellaneous constraints perceived by DSR farmers

(n=100)

S. No.	Miscellaneous constraints	Constraints			Total weighted score	Weighted mean score	Rank order
		Very serious (3)	Serious (2)	Not so serious (1)			
1.	Poor knowledge about using cyber communication source	41	27	32	207	2.07	II
2.	Depression due to paddy appearance is not good in the first two months	45	19	36	209	2.09	I
3.	No knowledge about Radio/T.V. programs related to DSR cultivation technology	36	25	39	197	1.97	III

Socio-economic impact of direct seeded rice method among farmers

Multiple socio-economic effects of direct seeded rice method were perceived by the farmers like about three-fourth of the farmers reported increased in socio-economic status (76%), expenditure on education of the children and increase in household assets facilities (73% each). About two-third of the respondents reported increase in expenditure on social ceremonies (66%), social mobility (61%), increase in urban contacts (55%) mass media exposure and change in family type (54% each) while 50% of the DSR adopters reported no change in quality of health services availed and in number and quality of dresses increased. Overwhelming majority regarding economic effects of direct seeded rice method reported saving of water (88%) with DSR than conventional transplanted rice method. In general 20-30% of water saving was reported by DSR adopters. Time saving and devotion on various other agricultural activities was reported by 70% of the farmers (Table 4).

Table 4: Socio-economic impact of Direct seeded rice method among farmers

(n=100)

S.N.	Socio-economic impact	DSR growers		
		Increase (%)	Decrease (%)	No change (%)
1.	Expenditure on social ceremonies	66	10	24
2.	Expenditure on education of the children	73	07	20
3.	Mass media exposure	54	15	31
4.	Urban contacts	55	9	36
5.	Extension contacts	33	14	53
6.	Quality of health services availed	41	9	50
7.	Increased household assets	73	-	27
8.	Social mobility pattern	61	5	34
9.	Number and quality of dresses	4	8	50
10	Expenditure on variety and quality food	31	20	49
11.	Change in socio-economic status	76	10	14
12.	Average cost of cultivation/ hac under DSR method	17	71	12
13.	Saving of water under DSR	88	-	12
14.	Use of modern agricultural machinery	61	13	26
15.	Time saving and devoted on various social activities	70	13	34
16.	Labour cost	11	67	22

It was concluded that majority of the farmers reported increase in socio-economic status, expenditure on education of their children and increase in household assets facilities etc. Regarding production, marketing, financial, technical guidance, input, and miscellaneous constraints in direct seeded rice method farmers reported very serious constraints like high weed infestation, lack of marketing facilities in village, hesitation in investing money in DSR method, non-availability of extension officials for technical guidance, high cost of seed and depression due to paddy appearance is not good in first two months etc. So there is a need to impart training to farmer to overcome the DSR method constraints.

Recommendation:

- Farmers lack sufficient understanding of direct seeding. Training should also be imparted to farmers to adopt direct seeded method..
- Training should also provide to integrated weed management
- Development of new rice varieties for direct seeding along with proper management practices can help in adoption of DSR.

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Socio - Economic Impact of Crop Residue Management through Rotavator on Farming Families

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ABSTRACT

Generally farmers are in a hurry to sow next crop (wheat) after cultivation of kharif crop (rice) and dispose off the straw immediately by burning and without recycling of crop residues. This is a great loss to the farmer as well to the land. Farmers resort to burning of the crop residue as removing it involves higher costs for labour to uproot, chop and mix in the soil. In order to encourage farmers to change this practice, rotavator machine was introduced to chop the harvested crop stalks / stubbles into small pieces and incorporated in-situ into the soil with varying efficiencies depending upon the left over residue. The rotavator prepares the field in single operation. It carries out secondary tillage operations such as harrowing and leveling in single operation. It destroys weeds, incorporates left-over stubbles of previous crop, conserves soil moisture and pulverizes soil. It prepares seed bed in both wet and dry conditions. It saves time, labour and cost. Keeping in view the perspectives of rotavator a study was conducted among 80 rotavator adopters in Kaithal district of Haryana to know socio economic impact of its adoption on farming families in 2017-18. Regarding reasons for adoption of overwhelming majority of the farmers (83.75%) reported that rotavators are capable of tilling large areas of land in a short time period and break up the soil & land leveling followed by eradicating of weeds (82.50%).Water management, time and fuel saving were also reported by majority of the respondents. Cumulative socio-economic impact of using rotavator like increased in investment on quality education of the children (83.33 %) and social ceremonies (79.16%) by medium land holding farmers were reported while investment on quality education of the children, payment of amount of credit availed from bank increased, extension contacts increased (80% each) were reported by marginal land holding farmers.
Key words: Rotavator, stubbles, socio-economic impact, eradication of weeds.

Introduction

Generally farmers are in a hurry to sow next crop (wheat) after cultivation of kharif crop (rice) and dispose off the straw immediately by burning and without recycling of crop residues because the time line available between the harvesting of paddy crop and the sowing of next crop is extremely short (2-3 weeks).Use of paddy straw is very less as fodder is limited due to high silica content. This is a great loss to the farmer as well to the land. Rice residue burning results is showing extensive impacts both on and off farm for e.g., losses soil nutrients, soil organic matter and its productivity, air and water quality biodiversity and on human and animal health also. In India, air pollution can be severe from residue burning, having impact on human health by directly causing a range of health hazards and significantly reduced visibility contributes the incidence of traumatic road accidents. In the rice-wheat cropping system, the losing of soil

organic matter as an effect of burning is one of the recognized threats to the sustainability. The straw collected from the fields is of great economic value as livestock feed, fuel and industrial raw material. In northern India, wheat straw is preferred while in Southern India paddy straw is fed to livestock (Hegde 2010).

The residue generated from the rice-wheat cropping system is of great use and also have many benefits, but this is possible only if the residue is separated from the grain and carried out of the field. Burning decreases the availability of straw to livestock, which is in short supply at present time by more than 40 %. However, in the case of combine harvesting, in great amount residue is left in the field for burning harmfully affect the overall sustainability of the rice-wheat cropping system (Thakur 2013). Now, many farmers have adopted Zero tillage after the stubble burning. In 2005–2006, around 10 % of the total area was sown under wheat by using zero till machines. Apparently less than 1 % of farmers have incorporation in the case of paddy straw because the incorporation requires more tillage operations than after burning (Singh et al. 2008). The options for crop residue management may include developing systems to plant residue into bailing and removal useful as animal feed or as industry. Enhanced decomposition or disintegration of machine-harvested straw improves nutrients in the soil is useful (Yadav, 2014).

The microbial sprays are useful which can speed up the decomposition of residue is also an option. The option of planting into residue needs additional investigation of inorganic nitrogen and its opposing effect due to nitrogen deficiency. Though numerous studies in the literature have addressed this issue of burning of the crop stubble but none have brought to the forefront adverse implications of this unwarranted run- through on both human and animal health. In order to encourage farmers to change this practice, rotavator machine was introduced to chop the harvested crop stalks / stubbles into small pieces and incorporated in-situ into the soil with varying efficiencies depending upon the left over residue. The rotavator prepares the field in single operation. It carries out secondary tillage operations such as harrowing and levelling in single operation. It destroys weeds, incorporates left-over stubbles of previous crop, conserves soil moisture and pulverizes soil. It prepares seed bed in both wet and dry conditions. It saves time, labour and cost (Kaur, 2016).

The rotavator will produce a perfect seedbed in fewer passes. It is the ideal implement for farmers who need to bury and incorporate crop residues quickly, between crops. Tillage tools direct energy into the soil to cause some desired effect such as cutting, breaking, inversion, or

movement of soil. Soil is transferred from an initial condition to a different condition by this process. A rotavator is a mechanical gardening tool with power blades attached to a spinning surface to plough soil and produce optimum tillage. In the aspects of saving power consumption and improving energy saving of agricultural machinery during soil cultivation, many scholars made a lot of research and practice on the influences of turning direction of rotary Rotary tiller or ROTAVATOR (derived from rotary cultivator) is a tillage machine designed for preparing land by breaking the soil with the help of rotating blades suitable for sowing seeds (without overturning of the soil). It also plays a vital role in eradicating weeds, mixing manure or fertilizer into soil, to break up and renovate pastures for crushing clods etc. It offers an advantage of rapid seedbed preparation and reduced draft compared to conventional tillage.

Methodology

The study was conducted in Kaithal district of Haryana in 2017-18. From the selected district, two blocks namely Pundri and Kaithal were selected randomly for the purpose of the study. From the selected blocks, Jamba, Dera Gadla, Khurana, Tayontha, Habri villages were drawn where more number of farmers were using Rotavator. From the selected villages 80 farmers were selected randomly. Interview Schedule was prepared for collection of data. Data was analyzed and tabulated to draw the inferences.

Results

Contextual matrix of the respondents

The data reported that majority of the respondents (53.75 %) were belonging to middle age group followed by young age group 28.75. The table further indicates that more than three-fourth of the respondents (78.75%) belonged to general caste, had nuclear family type (70.0%) with up to 4 members (65.0%). Regarding education 50 % of the respondents were educated secondary school level followed by senior secondary school level. Sixty percent of the respondents were having medium land holding (10.01-25.00) followed by small land holding. About half of the respondents (48.75%) belonged to medium (2.1 - 4.0 lakh) income group, had medium (40.0%) mass media exposure and social participation (43.75%) and socio economic status (41.25%).

Reasons for adoption of Rotavator by the respondents

Overwhelming majority of the farmers (83.75%) reported that rotavators are capable of tilling large areas of land in a short time period and break up the soil & land leveling followed by eradicating of weeds (82.50%) , higher income (81.25%) and easy to mixing manure or fertilizer

into soil (80.0%). Three-fourth per cent (77.50%) easier to operate than other types of

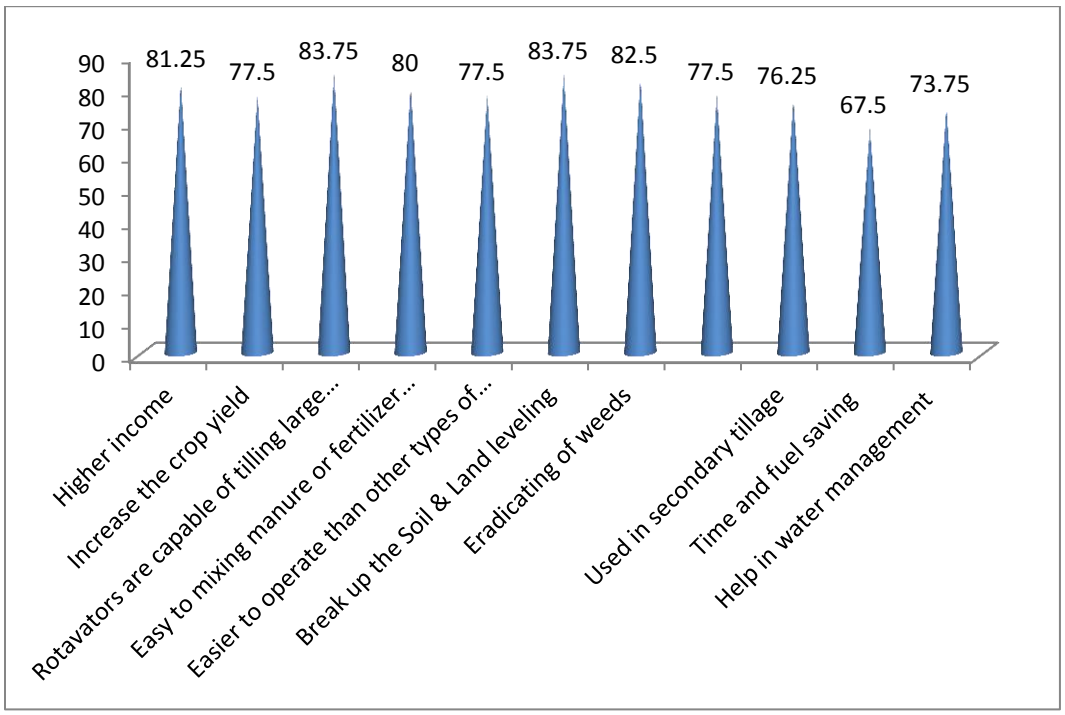

Fig.1: Reasons for adoption of rotavator by the respondents

machinery and easy in preparing the land suitable for sowing while 76.25 per cent of the respondents reported used in secondary tillage .Water management and time and fuel saving was also reported by 73.75% and 67.50% of the respondents. This result with the line of Jain, 2016 who find Surface retention of residue in soil can be managed by the technology of happy seeder and zero tillage. Rotavator is used in the combine harvested paddy fields for planting of wheat. Zero tillage is also used in standing stubbles of combine harvested rice after removing loose straw and easy to mixing manure or fertilizer into soil. Lohan 2018, Shafie 2016 and Jain 2014 also support this study they found the management of residue play significant role in protection of soil surface but also reduce the evaporation losses and water saving by the use of crops. The residue on the soil surface reduces the touching of sunlight and reducing the air exchange which resulted in less use of energy for the loss of water from the surface of soil (evaporation). The water saved with the management of residue is used by the crop for transpiration.

Table 1: Reasons for adoption of rotavator by the respondents in Kaithal district (2017-18)

(n=80)

S. No.	Reasons	Frequency	Percentage
1.	Higher income	65	81.25
2.	Increase the crop yield	62	77.50
3.	Rotavators are capable of tilling large areas of land in a short time period	67	83.75
4.	Easy to mixing manure or fertilizer into soil	64	80.00
5.	Easier to operate than other types of machinery	62	77.50
6.	Break up the Soil & Land leveling	67	83.75
7.	Eradicating of weeds	66	82.50
8.	Easy in prepare the land suitable for sowing	62	77.50
9.	Used in secondary tillage	61	76.25
10	Time and fuel saving	54	67.50
11	Help in water management	59	73.75

Responses were multiple

Cumulative Socio-economic impact of adoption of Rotavators on as farmers per size of holding

Table 2: Cumulative Socio-economic impact of adoption of Rotavators on farmers as per size of land holding in Kaithal district (n=80)

S.N.	Socio-economic change	Marignal (2.5Acre)	Small (2.51-50)	Semi-marignal	Medium (10.1-25)
		Freq. (%) (n=5)	Freq. (%) (n=15)	Freq. (%) (n=12)	Freq. (%) (n=48)
10.	Investment on quality education of the children	4(80.00)	7(46.66)	8(66.6)	40(83.33)
11.	Expenditure on social ceremonies increased	2(40.00)	-	6(50.00)	38(79.16)
12.	Household construction increased	3(60.00)	10(66.66)	7(58.33)	12(25.00)
13.	Increase in household assets	3(60.00)	12(80.00)	8(66.66)	24(50.00)
14.	Payment of amount of credit availed from bank increased	4(80.00)	8(53.33)	4(33.33)	10(20.83)
15.	Change in socio-economic status Social mobility increased	3(60.00)	9(60.00)	6(50.00)	12(25.00)
16.	Increase in land area on lease	2(40.00)	4(26.66)	5(41.66)	33(68.75)
17.	Increase in quality of medical treatment	3(60.00)	6(40.00)	6(50.00)	28(58.33)
18.	increased number and quality of dresses	4(80.00)	7(46.66)	4(33.33)	20(41.66)
10	Extensioncontacts increased	4(80.00)	8(53.33)	6(50.00)	24(50.00)

Analysis of data revealed cumulative socio-economic impact of using rotavator like increased in investment on quality education of the children (83.33 %) and social ceremonies (79.16%) by medium land holding farmers. Increased in household assets was reported by small (80%) and marginal farmers (60%), increase in land area on lease was reported by medium farmers (68.75%, increase in quality of medical treatment (60%), no. and quality of dresses increased (80%) and extension contacts increased (80%) were reported by marginal farmers. This study with tune of Kumar, 2016 and Roy 2016 also found in his study that the farmers who use rotavators have a great income and status too. Jain 2016, Yadav et al. 2014 and Kaur and Rani 2014 also support this study.

Conclusion

Farmers resort to burning of the crop residue as removing it involves higher costs for labour to uproot, chop and mix in the soil. In order to encourage farmers to change this practice, rotavator machine was introduced to chop the harvested crop stalks / stubbles into small pieces and incorporated in-situ into the soil with varying efficiencies depending upon the left over residue. The rotavator prepares the field in single operation. It carries out secondary tillage operations such as harrowing and leveling in single operation. It destroys weeds, incorporates left-over stubbles of previous crop, conserves soil moisture and pulverizes soil. It prepares seed bed in both wet and dry conditions. It saves time, labour and cost. Regarding reasons for adoption of overwhelming majority of the farmers (83.75%) reported that rotavators are capable of tilling large areas of land in a short time period and break up the soil & land leveling followed by eradicating of weeds (82.50%).Water management, time and fuel saving were also reported by majority of the respondents. Cumulative socio-economic impact of using rotavator like increased in investment on quality education of the children (83.33 %) and social ceremonies (79.16%) by medium land holding farmers were reported while investment on quality education of the children, payment of amount of credit availed from bank increased, extension contacts increased (80% each) were reported by marginal land holding farmers.

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Application of Central Composite Design in the Development and Optimization of Solid Dispersions System for Enhanced Solubility of Carvedilol

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ABSTRACT

Carvedilol is an antihypertensive drug is a poorly water-soluble drug and low oral bioavailability. Solid dispersion is techniques of solubility enhancement of poorly soluble drugs. The aim of the present work is to enhance the poor solubility of carvedilol using solid dispersion techniques.Nine formulations prepared by solvent evaporation and fusion method using polymers Hydroxy-methylcellulose (HPMC), Locust bean Gum (LBG), PEG 6000 and sodium starch glycolate (SSG). The samples were evaluated by solubility, stability, dissolution rate and characterized by Scanning electron microscopy (SEM), Powdered X-ray Diffractometry(PXRD), Differential Scanning Calorimetry(DSC) and Fourier Transform Infra-red (FTIR). Based on physicochemical evaluation and *in vitro* characterization, the solid dispersion drug content, percentage yield and drug release was found to be 94.06, 66.532, 93.20 and follows Peppas model. The FTIR was observed that Shifting of peaks confirmed the interaction of polymers with the pure drugs .SEM results shows that the prepared agglomerates were spherical in shape, which enabled them to flow very easily. The PXRD,SEM and DSC indicated a change in the crystalline state of Carvedilol. The enhancement of solubility was dependent on a combination of factors including the weight ratio, preparation techniques and carrier properties.

Introduction

Solubility of poorly water soluble drugs is allied with slow drug absorption leading to inadequate and variable bioavailability and gastrointestinal mucosal toxicity. The rate and extent of dissolution of the active ingredient from any dosage form often determines the rate of extent of absorption of the drug. When an active agent given orally, it must first dissolve in gastric and/or intestinal fluids before it can then permeate the membranes of the GI tract to reach systemic circulation[1,2]. Therefore, a drug with poor aqueous solubility will typically exhibit dissolution rate limited absorption, and a drug with poor membrane permeability will typically exhibit permeation rate limited absorption. Hence, two areas focus on improving oral bioavailability of active agents include: (i) enhancing solubility and dissolution rate

of poorly water-soluble drugs and (ii) enhancing permeability of poorly permeable drugs[3,4]

The oral bioavailability depends on several factors including aqueous solubility, drug permeability, dissolution rate, first-pass metabolism, pre-systemic metabolism, and susceptibility to efflux mechanisms. The Oral route is most desirable route of administering the dosage form. The major problem faced during the oral administration of active agent is the bioavailability. Solubility enhancement of various poorly soluble compounds is a challenging task for researchers and pharmaceutical scientists. Solubility parameter is used to achieve desired concentration of drug in systemic circulation for pharmacological response.[3-5]

A poorly water soluble drug, more recently, has been defined in general terms to require more time to dissolve in the gastrointestinal fluid than it takes to be absorbed in the gastrointestinal tract.

Drugs with low aqueous solubility have low dissolution rates and hence suffer from oral bioavailability problems. Solubility is an intrinsic property of any dosage form, i.e. drug.[4-6] property of drug product, wherein properties or nature of active compound can be improved by external modification i.e. by size reduction, due to which effective surface area of active component will be increased and enables more contact with intestinal fluids for better absorption of drug. [4-6] improved by internal modification i.e. by complexation of poorly soluble compounds with water soluble carrier. [4,5,7] The common aim for all of the drug delivery system is to increase the drug solubility. Some traditional and novel approaches to improve the solubility are Particle Size Reduction, Solid Dispersion, Nano suspension, Supercritical Fluid Technology, Cryogenic Technology, Inclusion Complex Formation Techniques, Floating Granules etc. [4-6]The term ‘Solid Dispersion’ refers to a group of solid products consisting of at least two different components, generally ‘a Hydrophobic Drug and a Hydrophilic Carrier’. The carrier can be either crystalline or amorphous form.[4, 5, 8]

Solid dispersion technique is a very useful method for pharmaceutical point of view because of its capability to solve the solubility problems by using solid dispersion method.[5, 9].Solid dispersion technique has been used for a variety of poorly aqueous soluble drugs such as

Nimesulide, Ketoprofen, Tenoxicam, Nifedipine, Nimodipine, etc. Various hydrophilic carriers such as PEG 6000, PVP, HPMC, gums, sugars, and Mannitol have been used for improvement of dissolution characteristics and solubility of poorly water soluble drugs. Solid dispersions can be prepared by various methods such as melting, solvent evaporation, solvent melting, spray drying, supercritical fluid techniques, etc.[4, 3, 9].

MATERIALS AND METHODS

Materials

Carvedilol was obtained as a gift sample Aurbindo Pharma Pvt Ltd. Hyderabad, India. HPMC, Locust Bean Gum, Peg 6000, Sodium Starch Glycolate and methanol were purchased from Himedialaboratories. All other chemicals were of analytical grade.

Drugs-excipient compatibility study

Optimization using Central Composite Design

Design Expert Software, version 11.0 (Stat-Ease, Inc. Minneapolis, MN, USA) was employed to fit polynomial equations with attached interaction terms for the correlation of studied responses with chosen variables. Drug content and % drug release were selected as response variables for systematic optimization. Optimized formulation was found by locating feasible space as well as exhaustive grid search was done for tracing the possible solution. Optimum solution was also provided by the software using the overlay plots. The optimized formulations were utilized for all the *in vitro* studies.[19- 21].The central composite design was selected for optimization because central composite design require 5 levels of each factor -α, -1, 0, 1, and +α. A statistical model incorporating interactive and polynomial terms were used to evaluate the responses.

$$Y = b_0 + b_1X_1 + b2X2 + b12X1X2 + b11X12 + b22X22$$

One way ANOVA (analysis of variance) was used for statistical analysis of targeted response at 5% significant level and the significance of model, factors were determined using Design- Expert 11.0. In above equation, b_0 is the intercept representing the arithmetic averages of all 13 runs and b1, b2, b12, b11 and b22 are the coefficients computed from the observed experimental values of responses Y1 , Y2, and X1 and X2 stand for main response of independent variables. The terms X1, X2, X11 and X2 represent interaction and quadratic terms of independent variables respectively.[19- 21]

Table 1: Formulation design of carvedilol with amount of HPMC, SSG, LBG& PEG 6000

Sr.No	Carvedilol(mg)	HPMC(mg)	SSG(mg)	LBG(mg)	PEG 6000(mg)
1	100	200	200	100	50
2	100	200	200	100	100
3	100	200	200	100	150
4	100	200	200	200	50
5	100	200	200	200	100
6	100	200	200	200	150
7	100	200	200	300	50
8	100	200	200	300	100
9	100	200	200	300	150

Fourier Transform Infrared Spectroscopy

Fourier transform infrared spectra were obtained using Shimadzu FTIR- 8400S spectrometer, Japan. Samples of carvedilol, gelucire 50/13, physical mixtures and solid dispersions were ground and mixed thoroughly with potassium bromide at a 1:5 sample/KBr ratio. The KBr discs were prepared by compressing the powders at a pressure of 5 T for 5 min in a hydraulic press. The scanning range was 40 to 4000 cm-1 and the resolution was 4 cm.[21, 22]

Differential Scanning Calorimetry

It is a thermoanalytical technique which is used to measure the temperature and heat flow associated with a transition in material as a function of time and temperature. [20, 21, 23, 24] Surface morphology of the agglomerates was accessed by SEM. The crystals were splutter coated with gold before scanning. The samples were then randomly scanned and microphotographs were taken on different magnification and higher magnification was used for surface morphology. The accelerator voltage wasset at 30.0 KV during scanning.[20, 21,19]

Powder X-Ray Diffractometry:-

Powder X-ray diffraction can be used to qualitatively detect material with long range order. Sharper diffraction peaks indicate more crystalline material. Recently developed X-ray equipment is semi-quantitative.(Dhirendra K *et al* 2009).XRD patterns were recorded using Philips PW 1729 X- ray generator, USA fitted with a copper target, a voltage of 40 kV, and a current of 30 ma. The scanning rate was 1°/min over a 2 θ range of 1-50°. PXRD patterns were traced for carvedilol, physical mixture and solid dispersions. The samples were slightly ground and packed into the aluminum sample container.[18-22]

Scanning Electron Microscopy (SEM)

The characteristic properties of drug crystals like particle size and morphological surface can be known by the preparation method and chemical composition. Additionally, the shape and granulometric properties of the powder particles can be explained through the range of parameters automatically obtained by connecting SEM with an image processor.[18, 19]

Drug Release Kinetics

To describe the kinetics of the drug release from matrix, mathematical model such as Zero-order, First order and Higuchi, models were used. The criterion for selecting the most appropriate model was chosen on the basis of the goodness- or fit test. [24-26]

***In- vitro* Drug Release Studies**

The *In-vitro* dissolution studies on pure drug (12.5mg) and physical mixtures and solid dispersion formulations of carvedilol were carried out in triplicate, employing USP XXIII paddle (Apparatus 2) using 900 mL 0.1 N HCL, as the dissolution medium at 100 rpm and 37±0.5˚C. An aliquots sample (10 mL) was periodically withdrawn at suitable time intervals and volume replaced with equivalent amount of dissolution medium. The samples were analyzed on spectrophometer at 241.2 nm using UV-visible spectrophotometer. [19-21]

Mechanism of Drug release:

The different mathematical models may be applied for describing the kinetics of the drug release process from dosage forms the most suited being the one which best fits to the experimental results. From formulations were determined by finding the best fit of the release data to zero order, first order and Higuchi and Korsmeyer- Peppas plot.[24-26]

Zero - Order Release Model

$$\mathbf{Q = Qo – Ko.t}$$

Where, Qo is the initial amount of drug, Q is amount of drug remaining at time t; Ko is zero-order rate constant expressed in units of concentration/ time and t is the time. A plot of the fraction of drug released against time will be linear if the release obeys zero order release kinetics.

First – Order Release Kinetic Model

Log Q = Log Q_o – K1.t/ 2.303

Where, Qo is the initial amount of drug, Q is amount of drug released at time t and k1 is first order constant. Thus, a plot of the logarithm of the fraction of drug remained against time will be linear if the release obeys first order release kinetics.

Higuchi Square Root Model

Q = K.t1/2

Where, Q is amount of drug released at time t and K is the constant reflecting the design variables of the system. A plot of the fraction of drug released against square root of time will be linear if the release obeys Higuchi equation. This equation describes drug release as a diffusion process based on the Fick's law, square root time dependant.

Korsmeyer – Peppas Model

Mt / M infinity = Ktn

Mt / M infinity is fraction of drug released at time t, K is the rate constant and n is the relase exponent .the n value is used to characterize different release mechanisms. . A plot between logof Mt/Mα against log time will be linear if the release obeys Peppas and Korsemeyer equation and the slope of this plot represents "n" value.

Results and Discussion

Melting Point of Drug

The melting point of carvedilol was determined by capillary method, melting point of carvedilol was found to be 114˚C -116.24˚C.

Fourier Transform Infrared Spectrophotometer(FTIR) Studies

Potassium bromide disc technique was employed to obtain the FTIR spectra of the drug and formulations using an FTIR spectrophotometer. The drug was identified by infrared spectroscopy and characteristics peak obtained compared with standard spectra of pure drug, physical mixture and formulation in figures. The IR spectra of pure drug showed the characteristics peaks at

3340.11cm^{-1}(N-H, stretching), 2978.17cm–1(C-H stretching),1399.84aromatic planbending,1647.61(MethyleneCyclohexane),1713.12(C=O),1598.26(C=C),2992.39(CH),1712.20(C=0),1660.66(methylenecyclohexane),1058.18(sulfoxides),1411.76(aromatic plane bending) and in physical mixture showed the peak at 2992.39(C-H),1712.20(C=O),1660.66(methylene cyclohexane),1058.18(sulfoxides),1411.76(aromatic plan bending), 1541.44(C=C) aromatic. But in case of formulation different peaks are shown at2973.20(C-H), 1054.07(sulfoxides), 1267.15(aromatic plane bending). Shifting of peaks confirmed the interaction of polymers with the pure drug.

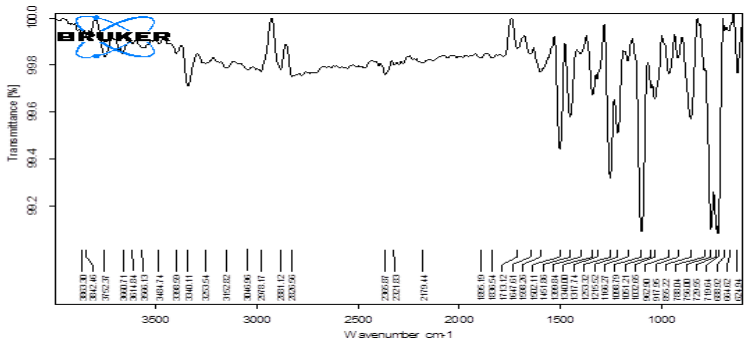

Figure 1 FTIR Spectra of Carvedilol

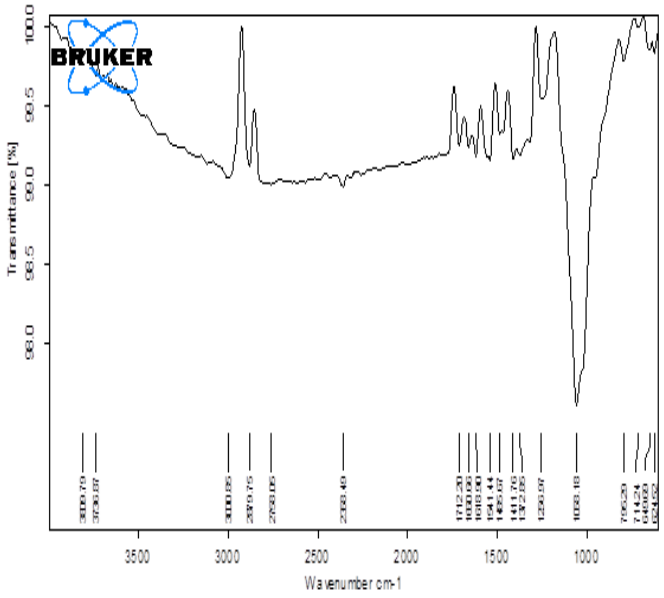

Figure 2.FTIR of Optimized Batch (F7)

Flow properties of solid dispersion method:-

Angle of repose

Angle of Repose determined by funnel method. The values were found to be within the range from 23.61±0.015 to 27.91±1.002. This indicated that powder blend having good flow property.

Bulk density and tapped density values

The range of formulation was found to be 0.240±0.020 to 0.850±0.010 and 0.320±0.010 to 0.610±0.01 respectively.

Hauser's ratio values and Carr's index

The range of formulation were found to be 1.06±0.02 to 1.33 ±0.045 and 12.09±0.51-27.1±0.01.It shows that powder blend having good flow property.

Table2.Powder Characteristics of Different Batches of Formulations (SE1-SE9)

Formulation code	Angle of repose (± SD)	Bulk Density (gm/ml)(± SD)	Tapped Density (gm/ml)(± SD)	Carr's Index(%)(± SD)	Hausner's Ratio(± SD)
SE 1	25.89 ± 0.06	0.53 ±0.01	0.57 ±0.01	13.49 ± 0.03	1.15 ±0.14
SE 2	26.02 ± 0.04	0.76 ±0.02	0.60 ± 0.01	14.96 ± 0.05	1.13 ±0.02
SE 3	26.14 ± 0.03	0.85 ± 0.01	0.59 ± 0.01	16.24 ± 0.05	1.06 ± 0.02
SE 4	25.54 ± 0.04	0.73 ±0.01	0.57 ±0.02	13.49 ± 0.14	1.09 ± 0.05
SE 5	26.07 ± 0.02	0.39 ±0.05	0.61 ±0.01	18.60 ± 0.13	1.09 ± 0.05
SE 6	26.23 ± 0.06	0.43 ±0.01	0.57 ±0.01	13.45 ± 0.05	1.11 ± 0.03
SE 7	27.24 ±0.05	0.68 ± 0.01	0.58 ±0.02	14.15 ± 0.08	1.14 ± 0.05
SE 8	26.45 ± 0.10	0.38 ±0.015	0.59 ±0.02	16.61 ± 0.09	1.13 ± 0.03
SE 9	26.54 ± 0.10	0.52 ±0.01	0.60 ±0.01	17.31± 0.03	1.07 ± 0.01

Table 3: Powder Characteristics of Different Batches of Formulations (FM1-FM9)

Formulation code	Angle of Repose(± SD)	Bulk Density (gm/ml)(± SD)	Tapped Density (gm/ml)(± SD)	Carr's Index(%)(± SD)	Hausner's Ratio(± SD)
FM 1	27.07 ±0.01	0.327 ±0.03	0.389 ±0.04	15.21 ±0.07	1.09 ±0.04
FM 2	25.71 ±0.06	0.26 ±0.01	0.336 ±0.01	15.27 ±0.01	1.15 ±0.01
FM 3	26.16 ±0.04	0.312 ±0.02	0.356 ±0.01	16.31 ±0.05	1.18 ±0.04
FM 4	25.53 ±0.30	0.394 ±0.002	0.449 ±0.002	12.09 ±0.51	1.175 ±0.007
FM 5	24.52 ±0.3	0.389 ±0.002	0.455 ±0.002	14.74 ±0.53	1.170 ±0.012
FM 6	25.1 ±1.001	0.24 ±0.01	0.320 ±0.01	24.98 ±2.79	1.33 ±0.045
FM 7	27.1 ±1.002	0.25 ±0.01	0.32 ±0.01	27.1 ±1.002	1.27 ±0.015
FM 8	27.36 ±0.015	0.445 ±0.001	0.529 ±0.002	16.00 ±0.02	1.17 ±0.015
FM 9	27.91 ±0.025	0.456 ±0.002	0.539 ±0.001	15.40 ±0.02	1.18 ±0.015

Percentage Yield

Percentage yield is the percent ratio of actual yield to theoretical yield. It is calculated to be the experimental yield divided by the theoretical yield multiplied by 100%.If the actual and theoretical yield are same. The percentage yield 100%.Usually percentage is lower than 100% because the actual yield is often less than the theoretical value.

Table 4.Percentage Yield of Solid Dispersions

Sr. No	Method	Range
1	Solvent evaporation method	53.60-75.23
2	Fusion method	60.40-72.21

The above table shows that the solvent evaporation method percentage (%) Yield of formulation was maximum as compare to fusion method.

Table 5. Comparative % Yield of Solvent Evaporation and Fusion Method

Formulation Code	%Yield (Solvent Evaporation Method)	Formulation Code	% Yield (Fusion Method)
SD 1	72.42	FM1	72.15
SD 2	67.24	FM2	69.28
SD 3	70.22	FM3	67.33
SD 4	64.74	FM4	60.40
SD 5	64.01	FM5	66.12
SD 6	69.33	FM6	64.35
SD 7	66.76	FM7	65.76
SD 8	71.93	FM8	67.11
SD 9	65.54	FM9	72.21

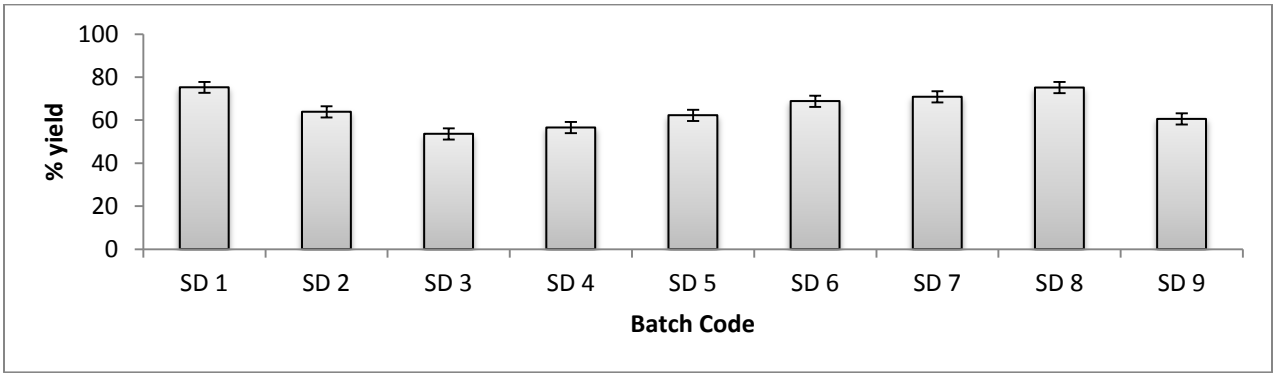

Figure 3.PercentageYield of the Formulation SD1-SD9 for Solvent Evaporation Method.

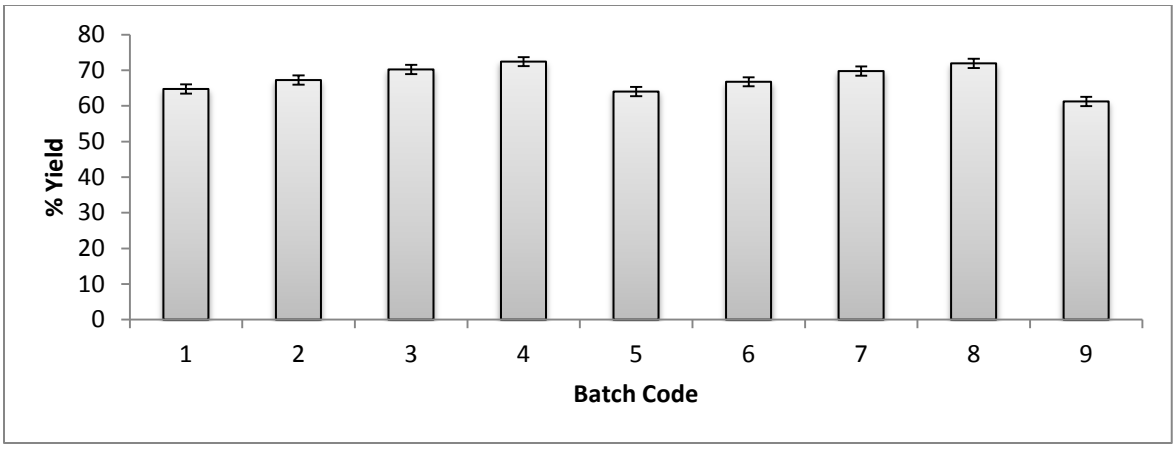

Figure 4.Percentage Yield of the Formulation 1-9 for Fusion Method.

Dissolution Study

All the prepared carvedilol solid dispersion were subjected to dissolution using paddle apparatus with 6.8 phosphate buffer solution and the results obtained for drug release were plotted as % cumulative drug release versus time in hours. The release data (0-90 minute) were fitted to different kinetics models, Zero models, First order, Higuchi Model and KorshmeyerPeppas model in order to study the mechanism of drug release in solid dispersion.

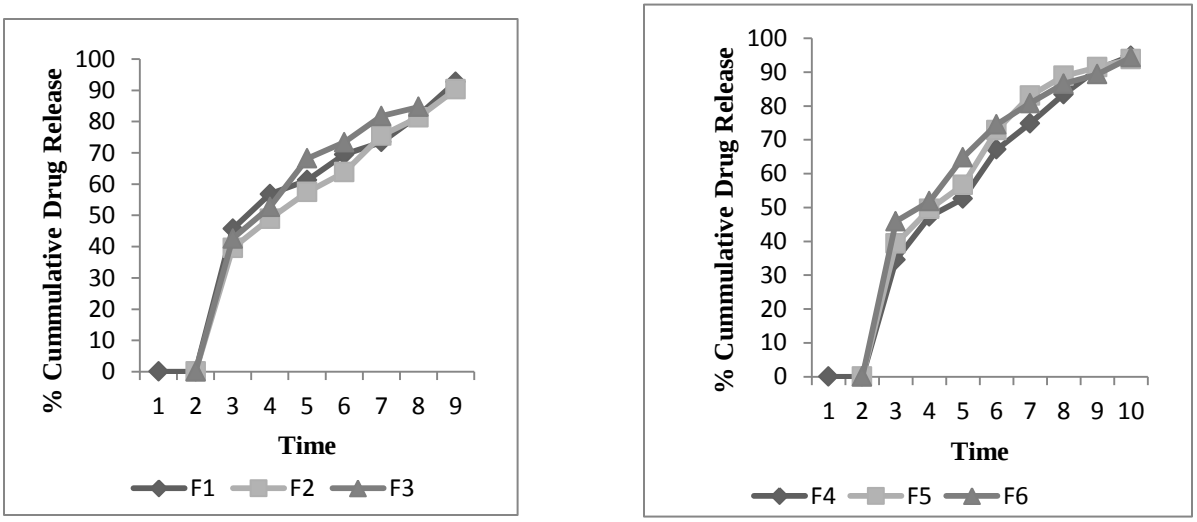

Figure 5. Percentage Cumulative Drug Release Vs Time for Formulations F1-F3&F4-F6

In-vitro dissolution profiles of pure drug and polymers and their respective mixtures in distilled water for 90 minutes are shown in figure. At the end of 90 minutes 62.47%,71.28%, 72.38%, 80.62%, 80.31%, 86.06%, 88.66% &93.46% release was observed. Carvedilol released from

pure drug sample.All of the samples of mixture showed improved dissolution of carvedilol. The solid evaporation method shows enhanced dissolution rate of the drug. The Solvent evaporation method increase the solubility and maximizing the surface area of the drug that came in contact with the dissolution medium as the carriers dissolved. This might due to effects of polymers in formulation. The drug release of 27.62% -93.46% was showed by solvent evaporation method.

Kinetics Models of Drug Release

Various kinetics models were applied on different batches of solid dispersion. Based on regression coefficients, F6 was selected to calculate kinetic parameters for drug release.

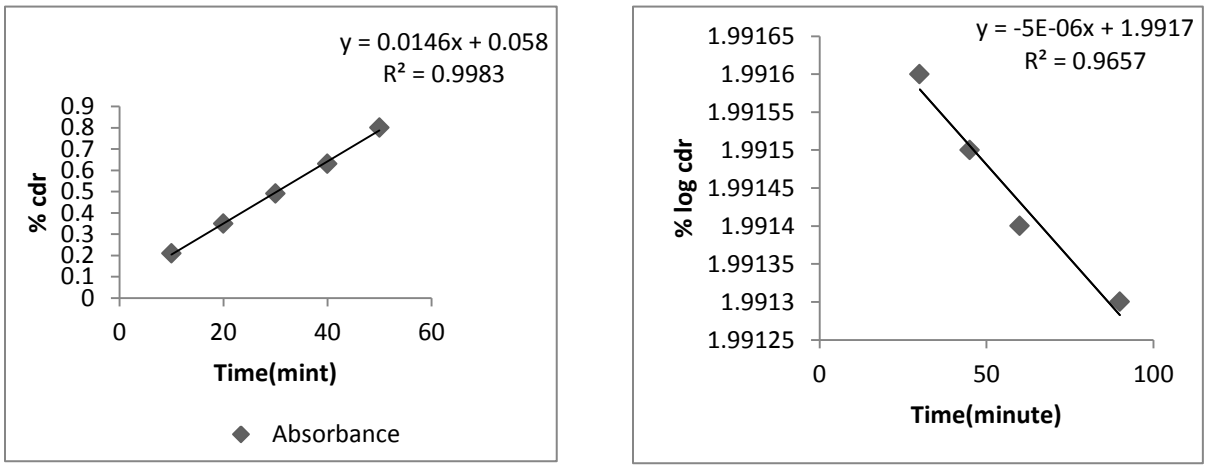

Figure6.The Zero order plot & First Order Plothaving regression coefficients (R^2) of 0.9983 & 0.9757

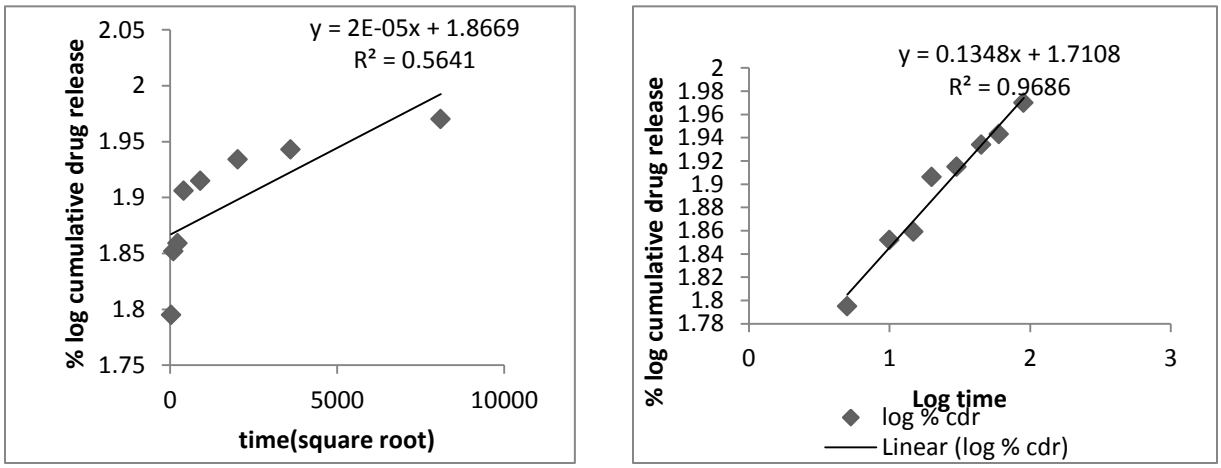

Figure 7.Higuchi Plot&Korshmeyer-PeppasModel Showing Regression Coefficients (R^2) of 0.9657& 0.9686

Table 7.R^2value of Various Kinetic Models Using Solvent Evaporation Method.

Sr No	Model	R^2 value
1	Zero order	0.7689
2	First order	0.9657
3	Higuchi	0.5641
4	Peppas	0.9686

Table shows that the method follows the Peppas model and R^2 value is 0.9686 is maximum in this model.

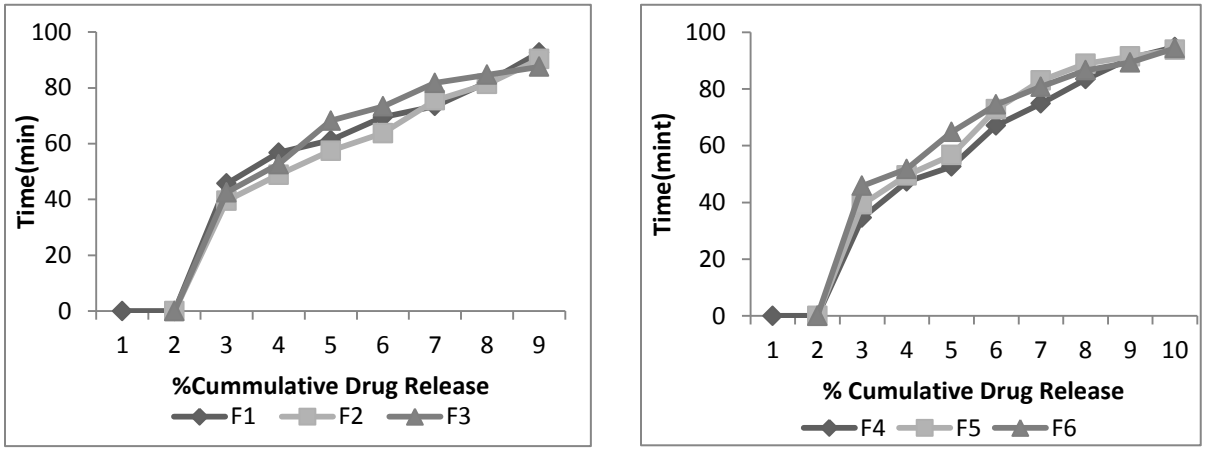

Figure8. PercentageCumulative Drug Release of Fusion Method Formulation F1-F3&F4-F6

In vitro dissolution profiles of pure drug and polymers and their respective mixtures in distilled water for 90 minutes are shown in figure. At the end of 90 minutes 45.87%, 51.78%, 64.81%, 74.52%, 74.52%, 80.76%, 86.54%,89.32% &94.34% Carvedilol released from pure drug sample FM1 –FM6. All of the samples of mixture showed improved dissolution of carvedilol. The Fusion method increase the solubility and maximizing the surface area of the drug that came in contact with the dissolution medium as the carriers dissolved. This might due to effects of polymers in formulation. The drug release 45.87%-94.34 in the Fusion method.[19, 20, 21]

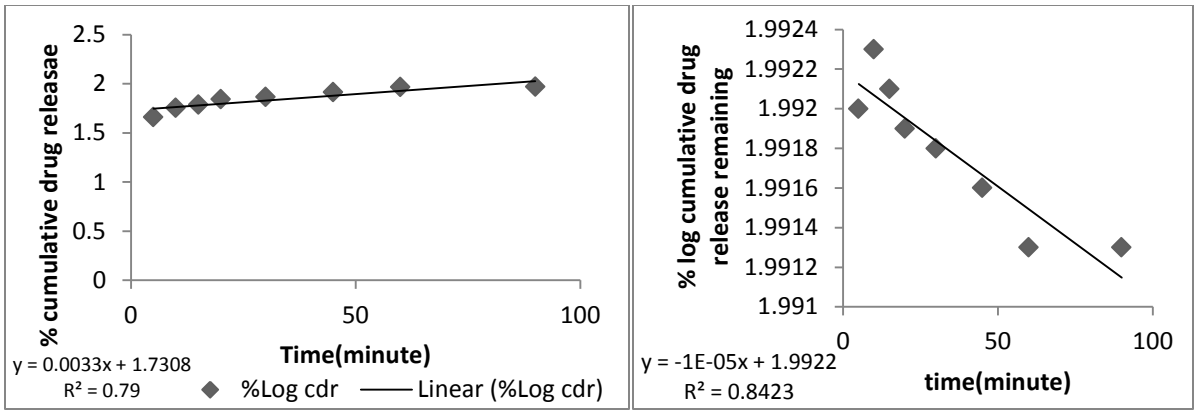

Figure 9.ZeroOrder&First Order Drug Releaseof the Fusion Method

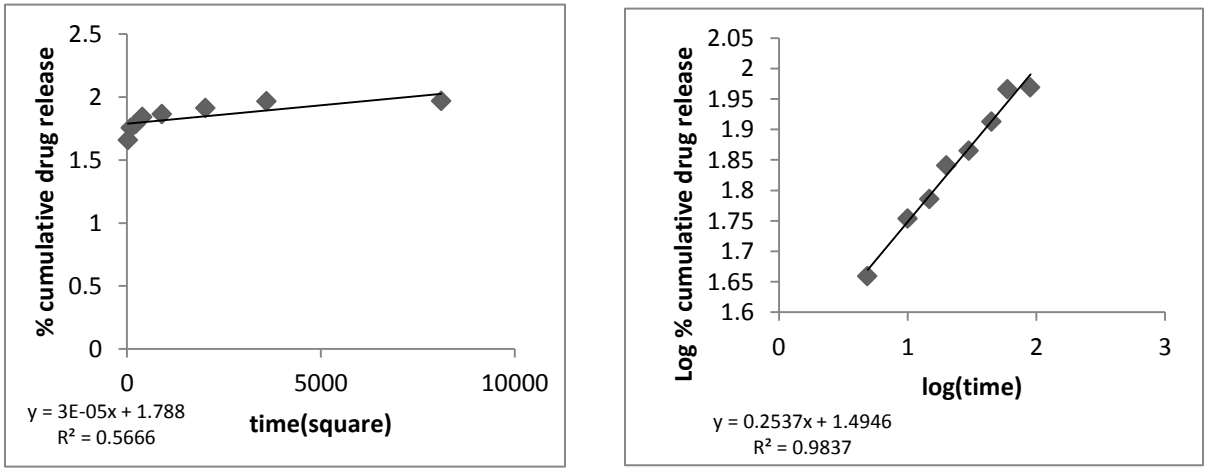

Figure 10.HiguchiModel&Peppas Model of Fusion Method

Table 6.R^2Value of Various Kinetic Models Using Fusion Method

Sr no	Model	R^2 Value
1	Zero- order	0.8061
2	First order	0.8061
3	Higuchi	0.5878
4	Peppas	0.9878

Table shows that the drug release in the fusion method follows the Peppas model and R^2 value is 0.9878.

Drug Content

The drug content of the formulation was found to be maximum in solvent evaporation method as compared with fusion method .Solvent evaporation method 96.34 ±0.03 and fusion method 95.20 ±0.02.

Table 7.Comparative Drug Content of carvedilol Solid Dispersions Using Solvent Evaporation & Fusion Method

Batch code	Drug Content of Solid Dispersion Solvent Evaporation method	Batch Code	Drug Content of Solid Dispersion Fusion Method
SE 1	95.45 ±0.28	FM 1	91.45 ±0.03
SE 2	96.12 ±0.01	FM 2	92.12 ±0.02
SE 3	94.34 ±0.02	FM 3	94.38 ±0.01
SE 4	94.87 ±0.01	FM 4	89.87 ±0.01
SE 5	95.12 ±0.02	FM 5	95.20 ±0.02
SE 6	93.54 ±0.03	FM 6	93.60 ±0.01
SE 7	94.02 ±0.02	FM 7	88.08 ±0.01
SE 8	95.23 ±0.01	FM 8	95.23 ±0.08
SE 9	96.34 ±0.03	FM 9	90.34 ±0.01

(SE-solvent evaporation, FM-Fusion method)

Optimization of Solvent Evaporation Method Using Design Expert 11software

Optimization was done by using Central composite design (CCD).Two variables X1(PEG 6000), X 2(Locust bean gum) and independent variables are percentage yield, Drug content, drug release are independent variables. Polynomial equation shows effect of factors or response variables.

The model F value for percentage yield was 7 and P-value was 0.0146 and R^2 value is 0.5102 and adjusted value of R^2 is 0.4013.It indicates that model is significant. Polynomial equation is 90.965 +1.64583A-0.844665B. Graph indicate in solvent evaporation method the percentage yield range 61.24-72.42.When we take the combination of proportion of locust bean gum and peg 6000 the drug percentage yield increases.Contour Plot Showed the effects of PEG 6000 and Locust Bean Gum and Concentration of HPMC and SSG Drug Content on % yield& it was obtained in range of 61.24-72.42.

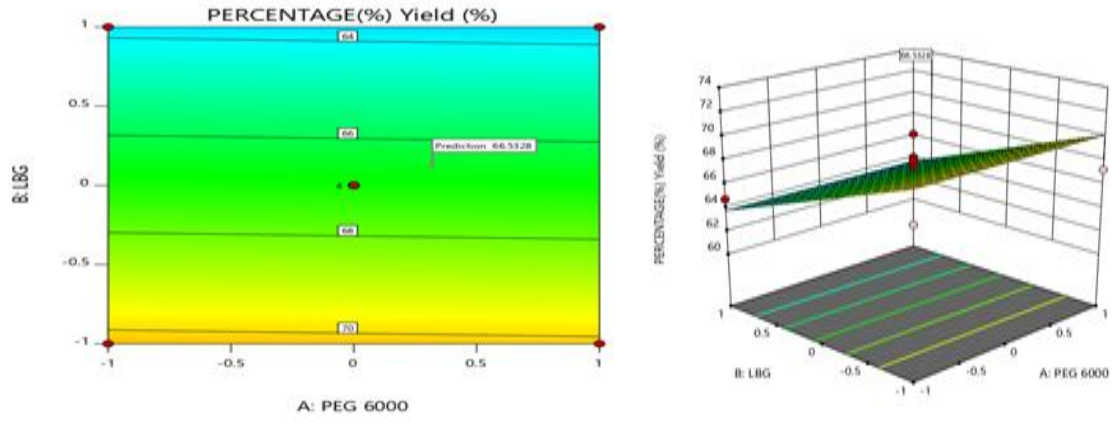

Figure11. Contour Plot of % Yield &3D Surface Plot Showing Effects of Locust Bean Gum And PEG- 6000on Percentage Yield.

The model F value for percentage yield was 4.55 and P-value was 0.02431 and R^2 value is 0.5027 and adjusted value of R^2 is 0.3922.It indicates that model is significant. Polynomial equation is 95.785+0.213306A+0.24125313+0.275AB-0.54 A^2-1.29$B^{2.}$ Percentage Drug release in solvent evaporation method the drug release range 78.34-93.54. In this graph indicate when the value of Locust bean is increase the drug release is decreases. When we increase the PEG6000 concentration the drug release is increase.

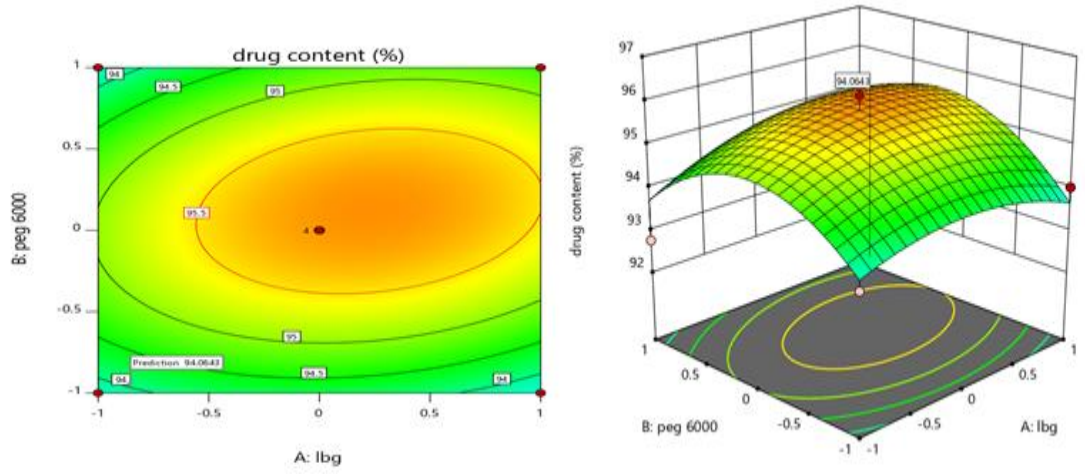

Figure 13. Contour plot showing effects of PEG 6000 and locust bean gum and concentration of HPMC and SSG drug content on Drug Content &3D Surface plot showing effect of locust bean gum and PEG 6000 on drug content.

X-Ray Diffraction

Powder X-ray diffraction analysis can be used to judge any changes in crystallinity of the drug which precipitated in an amorphous form, when formulated into a solid dispersion, which could be one of the mechanisms responsible for improved dissolution. X-ray diffraction of pure drug and polymers [°2θ] range is 5.8318-44.8085.Numerous diffraction peaks of carvedilol were observed a 12.9676, 14.826, 18.4392, 19.1257, 23.2702, 23.4898, 27.5381 indicating the presence of crystalline carvedilol

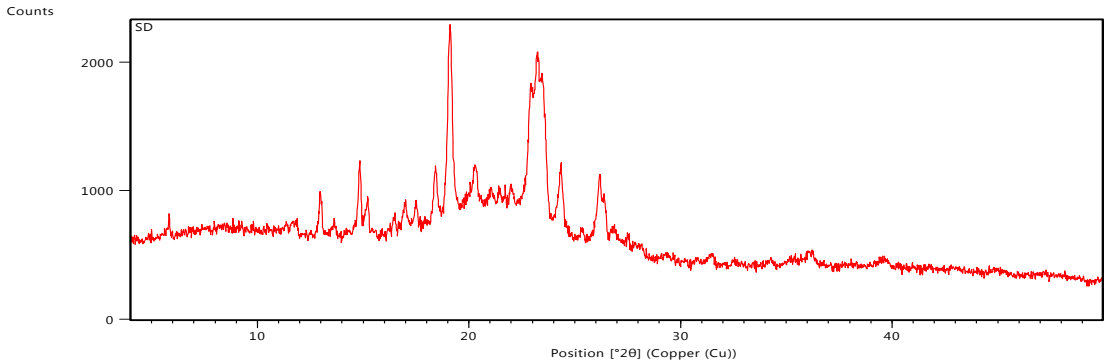

Figure 14. XRD Graph of Solid Dispersion of Optimized Batch

Scanning Electron Microscopy

The SEM (JEOL-JSM-6100)used SEM grids which were prepared by placing a small amount of solid dispersion formulation on a gold coated grid and drying under lamp SEM photomicrographs of carvedilol solid dispersion shown in figure. SEM photomicrographs of carvedilol solid dispersion indicated the solid dispersion was spherical in shape, which enabled them to flow very easily. These findings demonstrated that the drug was thoroughly mixed in the carriers with the loss of little crystallinity. Carvedilol crystals appeared to be incorporated into the particles of polymers.

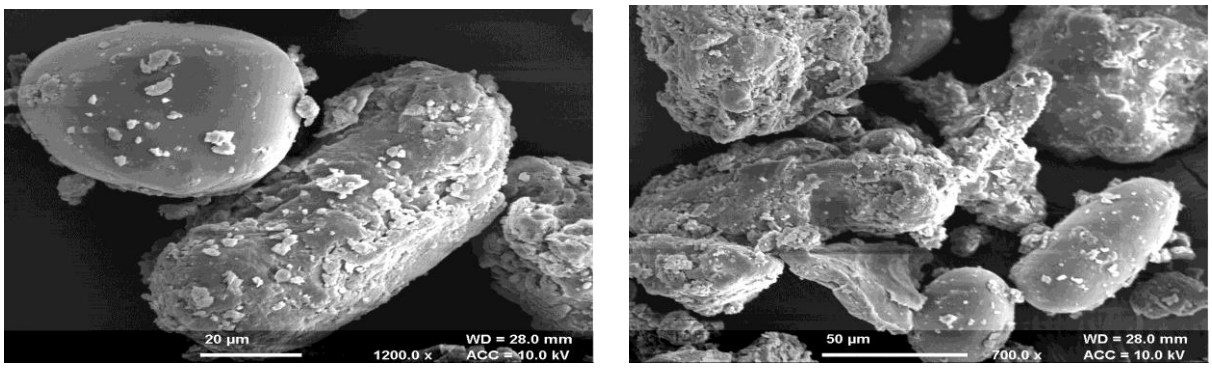

Figure 15. SEM photograph of optimized solid dispersion

Discussion:-

Solid dispersion is the most usable technique for improved solubility of poorly water soluble drugs and also increases the bioavailability of drug by avoiding the first pass metabolism and increases the therapeutic efficiency of drug by reaching into systemic circulation. Solid dispersion basically a drug-polymer with two component system. Carvedilol is a antihypertensive drug which is practically insoluble in water and used for treating mild to severe congestive heart failure(CHF),left ventricular dysfunction(LVD) following heart attack in people who are otherwise stable and for treating high blood pressure. The present study solubility enhancement of antihypertensive drug (carvedilol) using solid dispersion method using different carriers HPMC, Locust bean gum, PEG 6000&Sodium starch glycolate.

Locust bean gum is a galactomannan vegetable gum extracted from seeds of carob tree and used as a binding agent, flavorings agent etc. HPMC is used as a viscosity increasing agent in formulation.PEG 6000 is used as a plasticizer which increases the solubility of formulation using solid dispersion in appropriate polyethylene glycol. Sodium starch glycolate is used as a disintegrants in formulation. In this study we prepared the solid dispersion of carvedilol using solvent evaporation method and fusion methods. In both the methods various carriers are used in formulations. The results produced were characterized by X-RD, SEM, *in vitro* dissolution studies.

Potassium bromide disc technique was employed to obtain the FTIR spectra of the drug and formulations using an FTIR spectrophotometer. The drug was identified by infrared spectroscopy and characteristics peak obtained compared with standard spectra of pure drug, physical mixture and formulation in figures. The IR spectra of pure drug showed the characteristics peaks at 3340.11 cm^{-1} (N-H, stretching), 2978.17 cm–1 (C-H), 1399.84 aromatic plane bending,

1647.61(MethyleneCyclohexane),1713.12(C=O),1598.26(C=C),2992.39(CH),1712.20(C=0),166 0.66(methylenecyclohexane),1058.18(sulfoxides),1411.76(aromatic plane bending) and in physical mixture showed the peak at 2992.39(C-H),1712.20(C=O),1660.66(methylene cyclohexane),1058.18(sulfoxides),1411.76(aromatic plan bending), 1541.44(C=C) aromatic. But in case of formulation different peaks are shown at 2973.20(C-H),1054.07(sulfoxides),1267.15(aromatic plane bending). Shifting of peaks confirmed the interaction of polymers with the pure drugs .

The formulations were prepared by direct solvent evaporation, physical mixing and fusion method .The angle of repose values for formulations range from 23.61±0.015 to 27.91±1.002. and respectively .Bulk and tapped densities were used for the measurement of compressibility index .The bulk and tapped values for formulations range from 0.240±0.020 to 0.850±0.010 and 0.320±0.010 to 0.610±0.01 respectively. The Carr's index and Hauser's ratio values for formulations range from 12.09±0.51-18.60±0.13 and 1.06±0.02 to 1.33 ±0.045 respectively. Thus all formulations exhibited good flow characteristics.

Carvedilol solid dispersion were formulated according to central composite designs(CCD) to study the effect of independent variables on solid dispersion of carvedilol. The methods differs in the process of solid dispersion formulations. Optimization of carvedilol is done by using design expert software-11.In optimization two independent factors X_1 (locust bean gum),X_2(Peg 6000).In percentage yield range of optimized batch is 66.5328.The combination of proportion of locust bean gum and peg 6000 the percentage yield increases. In the drug release the concentration of locust bean increases drug release decreases, when we increase the peg 6000 concentration drug release is increases. The optimized drug release value is 90.2833. In drug content combination of polymers increase the drug content increases the optimized range is 94.0643. *In vitro* drug release study solvent evaporation method 93.46 is maximum drug releases and in fusion method 93.20.Both the model follows the peppas models and R^2 value in solvent evaporation method is 0.9686 and in fusion method is 0.9878 and follows the peppas model and drug release is 93.20.At last the optimized batch X-ray diffraction value is 2θ is 5.8318- 44.8085 and scanning electron microscopy the results shows that the prepared agglomerates were spherical in shape, which enabled them to flow very easily.

Conclusion

The study was done to perform the solubility enhancement of carvedilol using solid dispersion method.

Acknowledgments

The authors are thankful to instrument laboratory Punjab University, Chandigarh, for technical support.

Conflict of Interest

No conflict of interest

evaluation, in-vitro characterization, the drug release was maximized because of the increase in the amount of hydrophilic polymers to hydrophobic polymer maximize drug release and increased concentration of polymers produce reproducible results. This study indicated that the solubility of carvedilol was increased by solvent evaporation method when compared with fusion method. Incorporation of hydrophilic polymers in solid dispersion increases dissolution rate of the drug. hydrophilic polymers (HPMC, locust bean gum) and PEG 6000 and sodium starch glycolate as plasticizer and Disintegrate. evaporation and fusion method using All the prepared formulations showed good uniformity regards to drug content, percentage yield, and physiochemical parameters, drug release. Based on

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Effect of Foliar Application of Micronutrients on Growth, Yield and Fruit Quality of Guava (*Psidium guajava*) cv. Allahabad Safeda

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ABSTRACT

The present investigations on **"Effect of foliar application of micronutrients on growth, yield and fruit quality of Guava (*Psidiumguajava*) cv. Allahabad safeda"** was conducted at the farm, Village- SarawanBodla, Tehsil- Malout, Distt- Sri Muktsar Sahib, Punjab during 2018-2019. Experiments were laid out in randomized block design (RBD) with thirteen treatments viz. T_1- Zn_1 @ 0.5 %, T_2-Zn_2 @ 1.0 %, T_3-Cu_1 @ 0.5 %, T_4- Cu_2 @ 1.0 %, T_5- B_1 @ 0.5 %, T_6-B_2 @ 1.0 %, T_7- Fe_1 @ 0.5%, T_8- Fe_2 @ 1.0 %, T_9 Mg_1 @ 0.5 %, T_{10} Mg_2 @ 1.0 %, T_{11} Mn1 @ 0.5 %, T_{12} Mn_2 @ 1.0 % and T_{13} Control. The maximum growth parameters *viz*., plant height (cm), stem girth (cm) canopy volumeE-W (m), canopy volume N-S (m)were reported with the application of T_2*i.e.*Zn_2 @ 1.0 % which was at par with application of T_1-Zn1 @ 1.0 % and T_4 – Cu2 @ 1.0 % and it was significantly superior over the other treatments at all stages of observation. The maximum yield kg plant^{-1} and total no. of fruits plant^{-1} was recorded in T_2*i.e.*Zn_2 @ 1.0 %which was at par with application of T_1-Zn_1 @ 1.0 % and T_4 – Cu_2 @ 1.0 %and it was significantly superior over all treatments. The maximum fruit weight was reported in T_2*i.e.*Zn_2 @ 1.0 %which was at par with application of T_1-Zn_1 @ 1.0 % and T_4 – Cu_2 @ 1.0 %. The maximum chemical parameters *viz.*, TSS (^{0}Brix), ascorbic acid (mg/100g) and all sugars (%) were reported with the application of T_2*i.e.* .Zn_2 @ 1.0 % which was at par with application of T_1-Zn_1 @ 1.0 % and T_4 – Cu_2 @ 1.0 % and it was significantly superior over the other treatments at all stages of observation.

Keywords: Guava, Micronutrient, RBD, Foliar, yield, fruit quality

INTRODUCTION

Guava (*Psidiumguajava*L.) is one of the most popular fruits grown in tropical, sub-tropical regions of India, which belongs to the family Myrtaceae. It is the fifth most important fruit in area after mango, banana, citrus and apple and fifth most important fruit in production after banana, mango, citrus and papaya.This fruit is a native of tropical America and extensively grown in South Asian countries. It is successfully grown all over the country but leading guava growing states are Uttar Pradesh, Bihar. Rewa, Neemuch, Ratlam, Khandwa and Mandsaur (Anonymous, 2018). In India, guava shares 4.5 % in area and 11.4 % in production and the total area and production of guava are about 0.26 million hectare and 39,97,000 MT, respectively (Anonymous, 2018).

Guava fruit contains water (80-82%), protein (0.71%), fat (0.5%), carbohydrate (11-13%) and acids (2.4%). Among fruits, it ranks third in vitamin-C content after Barbados cherry and Aonla. Guava fruits are rich in dietary fibers and vitamin C and have moderate levels of folic acid (Rajkumar*et. al.* 2017). It also contains substantial quantities of carbohydrates, sugars and pectin. Owing to excellent taste and flavor, high nutritional value and wide availability at moderate price the fruit is often called as "Poor man's apple" (Suman *et. al.* 2016).

Foliar application is based on the principle that the nutrients are quickly absorbed by leaves and transported to different parts of the plant to fulfill the functional requirement of nutrition. This method is highly helpful for the correction of element deficiencies to restore disrupted nutrient supply, overcome stress factors limiting their availability and it plays a very important role in improving fruit set, productivity and quality of fruits and recovery of nutritional and physiological disorder in fruit trees (Shukla, 2011).

Foliar Fertilization of nutrients is advantageous in terms of low application rate, uniform distribution of fertilizer materials and quick response to applied nutrients (Mishra *et al*., 2017). However, plants with no foliar application showed un-satisfactory results regarding all the parameters. Too low or high concentration of Zinc solution may reduced the yield and yield parameters of guava (Arshad and Ali 2016).

MATERIAL AND METHOD

The experiment was conducted in the research farm of Mr. Lakhwinder Singh, Village-SarawanBodla, Tehsil- Malout, Dist- Sri Muktsar Sahib. The present investigations were made on eight year old Guava trees growing in the Orchard. Thirty nine trees which were uniform in size & vigour and given cultural practices as per package of practices recommended by Punjab Agricultural University, Ludhiana were selected for the present study. All the treatment was applied as a last week September. During the course of studies, recommended cultural practices were followed in the experimental materials.Experiments were laid out in randomized block design (RBD) with thirteen treatments viz. T_1- Zn_1 @ 0.5 %, T_2- Zn_2 @ 1.0 %, T_3- Cu_1 @ 0.5 %, T_4- Cu_2 @ 1.0 %, T_5- B_1 @ 0.5 %, T_6-B_2 @ 1.0 %, T_7- Fe_1 @ 0.5%, T_8- Fe_2 @ 1.0 %, T_9 Mg_1 @ 0.5 %, T_{10} Mg_2 @ 1.0 %, T_{11} Mn1 @ 0.5 %, T_{12} Mn_2 @ 1.0 % and T_{13} Control.

Observations were recorded on growth parameters like Plant height (cm), Leaf area (cm^2) and Yield parameters like Total number of fruits (per tree), Fruit yield (kg/ tree and t/ha) and also Fruit quality parameters like Total soluble solids (TSS), Acidity (Titrable acidity), Ascorbic acid (mg/100g) and Total sugars (%).

RESULTS AND DISCUSSION

GROWTH PARAMETERS

The data pertaining to the tree height of different treatment combinations have been presented in table-1.It is evident from the Table that different treatments strikingly resulted in difference in average tree height of plant. Maximum tree height increase (27.33 cm) was recorded in treatment T_2 (Zn_2 @ 1 %) which was statistically at par with height increase 24.67 cm in treatment T_4 (Cu_2@ 1 %) and 21 cm in treatment T_1 (Zn_1 @ 0.5 %). The minimum tree height (12 cm) was recorded in treatment T_{13} (control).

The relevant data of leaf area different treatment combinations have been presented in table represented in Table-1.It is clearly evident from the data that different treatments show significant difference in leaf area. From Table it is clearly showed that the maximum leaf area was recorded 41.51 cm^2 in treatment T_2 (Zn_2 @ 1 %) which was statistically at par with 40.74 cm^2 in treatment T_1 (Zn_1 @ 0.5 %) and 39.67 cm^2 in treatment T_4 (Cu_2 @ 1 %). The minimum leaf area (29.14 cm^2) was recorded in treatment T_{13} (control).

These results are in agreement with the findings of Kumar*et al*. (2015), Razzaq et al. (2013), Neilsen and Hogue (1983).

YIELD PARAMETERS

It is clearly evident from the data that different treatments show significant difference in no. of fruits per tree. From it is clearly showed that the maximum no. of fruits (228.67) was found in treatment T_2 (Zn_2 1.0 %) which was statistically at par 220.33 in treatment T_1 (Zn_1 0.5 %) and 213.33 in treatment T_4 (Cu_2 1.0 %). The minimum no. of fruits (190.67) was recorded in treatment T_{13} (control). It is clearly evident from the data that different treatments show significant difference in yield per tree. It is clearly showed that the maximum yield per tree (42.81 kg) was observed in treatment T_2 (Zn_2 1.0 %) which was statistically at par 40.80 kg in treatment T_1 (Zn_1 0.5 %) and 40.16 kg in treatment T_4 (Cu_2 1.0 %). The minimum yield per tree (18.22 kg) was recorded in treatment T_{13} (control).These results are in agreement with the findings ofZagade*et al*. (2017).

FRUIT QUALITY PARAMETERS

From Table-2 it is clearly showed that the maximum fruit TSS 8.96 (^{0}Brix) was recorded in treatment T_2 (Zn_2 @ 1.0 %) which was statistically at par TSS (8.89 ^{0}Brix) in treatment T_1 (Zn_1 @ 0.5 %) and 8.64 ^{0}Brix in treatment T_4 (Cu_2 @ 1.0 %). The minimum TSS (7.24 ^{0}Brix) was

TABLE 1:- Effect of Foliar application of micronutrients on tree height and leaf area of guava tree.

Symbol	Treatments	Tree height increase (cm)	Leaf area (cm^2)
T_1	Zn_1 @0.5 %	21.00	40.74
T_2	Zn_2 @ 1.0 %	27.33	41.51
T_3	Cu_1 @ 0.5 %	19.33	37.43
T_4	Cu_2 @ 1.0 %	24.67	39.67
T_5	B_1 @ 0.5 %	18.00	37.39
T_6	B_2 @ 1.0 %	23.00	34.67
T_7	Fe_1 @ 0.5 %	14.67	33.20
T_8	Fe_2 @ 1.0 %	19.67	32.97
T_9	Mg_1@ 0.5 %	14.00	32.17

T_{10}	Mg_2 @ 1.0%	19.00	32.37
T_{11}	Mn_1 @ 0.5%	13.67	32.14
T_{12}	Mn_2 @ 1.0%	15.67	31.80
T_{13}	Control	12.00	29.14
S. Em. ±		1.41	0.98
$CD_{(0.05)}$		4.11	2.87

Table-2:- Effect of foliar application of micronutrients on TSS, ascorbic acid and titratable acidity of guava fruit.

Symbols	Treatments	TSS (^{0}Brix)	Ascorbic acid (mg/100g)	Acidity (titratable acidity)
T_1	Zn_1 @0.5 %	8.89	173.72	0.61
T_2	Zn_2 @ 1.0 %	8.96	179.14	0.52
T_3	Cu_1 @ 0.5 %	8.43	162.36	0.70
T_4	Cu_2 @ 1.0 %	8.64	169.92	0.70
T_5	B_1 @ 0.5 %	8.26	156.34	0.70
T_6	B_2 @ 1.0 %	8.42	152.51	0.72
T_7	Fe_1 @ 0.5 %	8.30	149.26	0.70
T_8	Fe_2 @ 1.0 %	8.25	150.31	0.71
T_9	Mg_1@ 0.5 %	8.56	147.35	0.71
T_{10}	Mg_2 @ 1.0%	8.36	149.38	0.73
T_{11}	Mn_1 @ 0.5%	7.39	147.92	0.71
T_{12}	Mn_2 @ 1.0%	7.78	145.58	0.72
T_{13}	Control	7.24	137.12	0.80
S. Em. ±		0.16	3.36	0.02
$CD_{(0.05)}$		0.46	9.80	0.07

Table-3:- Effect of foliar application of micronutrients on total sugar of guava fruit.

Symbols	Treatments	Total sugar
T_1	Zn_1 @0.5 %	8.23
T_2	Zn_2 @ 1.0 %	8.30
T_3	Cu_1 @ 0.5 %	7.06
T_4	Cu_2 @ 1.0 %	8.16
T_5	B_1 @ 0.5 %	7.07
T_6	B_2 @ 1.0 %	6.78
T_7	Fe_1 @ 0.5 %	6.87
T_8	Fe_2 @ 1.0 %	7.12

T_9	Mg_1@ 0.5 %	6.85
T_{10}	Mg_2 @ 1.0%	6.55
T_{11}	Mn_1 @ 0.5%	6.53
T_{12}	Mn_2 @ 1.0%	6.29
T_{13}	Control	6.06
S. Em. ±		0.08
$CD_{(0.05)}$		0.25

recorded in treatment T_{13} (control). The relevant data ascorbic acid of different treatment combinations have been presented in Table-3. From Table it is clearly showed that the maximum fruit titratable acidity (0.80) was recorded in treatment T_{13} (control) which was statistically at par 0.73 in treatment T_{10} (Mg_2 @ 1.0 %). The minimum fruit titratable acidity (0.52) was recorded in treatment T_2 (Zn_2 @ 1.0 %).

The data reported that total sugars of different treatment combinations have been presented in Table-4. It is clearly evident from the data that different treatments show significant difference in total sugar. From Table it is clearly showed that the maximum fruit total sugar (8.30 %) was recorded in treatment T_2 (Zn_2 @ 1.0 %) which was statistically at par (8.23 %) in treatment T_1 (Zn_1 @ 0.5 %) and (8.16 %) in treatment T_4 (Cu_2 @ 1.0 %). The minimum total sugar (6.06 %) was recorded in treatment T_{13} (control).

CONCLUSION

On the basis of results obtained from various treatments, it can be concluded that the application of treatment T_2*i.e.* Zn_2 1.0 % gave best results in quality and yield parameters which was at par with treatment T_1*i.e.* Zn_1 0.5 % and T_4*i.e.* Cu_2 1.0 %.

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