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EFFECT OF PLANTING METHODS, ORGANIC NUTRIENT SOURCES AND BIO-FERTILIZERS ON BULB YIELD AND QUALITY OF *KHARIF* ONION (*ALLIUM CEPA* L.)

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Abstract

The experiments were conducted at the village- Rawar, near College of Agriculture, Gwalior (M.P.), India during two consecutive years of *Kharif* seasons in 2013-14 and 2014-15 to evaluate the effect of planting methods, organic nutrient sources and bio-fertilizers on quality and economics of *Kharif* onion in Gwalior conditions. The results of the experiment was revealed that the ridge method of planting resulted in significantly highest protein content (6.34%) over furrow and flat method of planting and maximum TSS (12.52%) was also recorded with ridge method, which was at par with rest of both sowing methods. The interactions were found not significant response with these parameters. Seedlings inoculated with PSB transplanted on ridges with 25.0 t FYM/ha and PSB 5 kg/ha ($P_3S_2B_1$) accrued the highest net monetary return amounting Rs. 97060/ha followed by $P_3S_2B_2$ (Rs. 93790/ha) and $P_3S_1B_1$ (Rs. 91260/ha) while the highest B: C ratio of 2.65 was obtained with the treatment combination ridge planting with 12.5 t FYM/ha and PSB 5 kg/ha closely followed by $P_3S_1B_2$ (2.58), $P_3S_2B_1$ (2.57) and $P_3S_2B_2$ (2.52).

Key words : Onion, planting method, organic nutrient sources, bio-fertilizer, bulb yield and quality.

Introduction

Onion [*Allium cepa* L.] commonly known as 'PYAJ' belongs to the family Amaryllidaceae. It is a bulbous biennial herb of the most important vegetable cum condiments, spice crops demanded worldwide. Onion has a paramount effect in preventing heart diseases and other ailments (Saini, 1997). India is the second largest producer of onion in the world, next to China, with 70% of the total production comes as winter crop and remaining 30% as *kharif* onion as off season crop, accounting for 11.40 per cent of the area and 10.40 per cent of the world production and 16 per cent of productivity. In India, onion is being grown in an area of 3.64 million hectares with production of 68.45 million tonnes and the average productivity is 18.82 tonnes per hectare. China, India, U.S.A., Pakistan, Turkey, Iran, Brazil, Mexico and Spain are the major onion producing countries in the world. Maharashtra is the leading onion growing state of India (Anonymous, 2013).

The onion is water sensitive crop and thus the scarcity and lodging of soil water is degrading the quantity and quality of produce. The production of onion in *kharif* season is economically beneficial for farmer, but the water lodging situations drastically reduced the production of crop. So the sowing method provide an option to safely produce the onion in *kharif* season by providing protection from water lodging and moisture conservation in soil during crop season. The organic manures contain nutrients in small quantities as compared to the chemical fertilizers, also it contain growth promoting substances like enzymes and hormones, besides improvement of soil fertility and productivity (Bhuma, 2001). Organic materials such as poultry manure, green manures and farmyard manure (FYM) can substitute for inorganic fertilizers to maintain productivity and environmental quality (Choudhary *et al*., 2002). The bio-fertilizers are alternative sources to meet the nutrient requirement of crops and to bridge the future gaps. Further, knowing the deleterious effect of using only chemical fertilizers on soil health, use of chemical fertilizers supplemented with organic waste and bio-fertilizers will be environmentally benign.

Materials and Methods

The experiments were conducted at the village-Rawar, near College of Agriculture, Gwalior (M.P.), India during the *Kharif* seasons of 2013-14 and 2014-15 to evaluate the effect of planting methods, organic nutrient sources and bio-fertilizers on bulb yield, quality and economics of *Kharif* onion in Gwalior conditions. The average rainfall ranges 650 to 751 mm, average minimum and maximum temperature during growing period is 20.2°C and 32.2°C, respectively. The total rainfall received during the crop season from June, 2013 to December, 2013 and June, 2014 to December, 2014 was 666.8 mm and 581.8 mm, respectively. The soil of the experimental field was sandy loam in texture and pH values 7.9 and 8.0 with 4.56 and 4.80% organic carbon content, analyzing low in available N (212.7 and 215.2 kg/ha), medium P (15.76 and 14.98 kg/ha) and K (286.0 and 281.0 kg/ha) contents having 0.12 and 0.14 mmhos/cm electrical conductivity in 2011-12 and 2012-13, respectively. The experiment was laid out in split-split plot design with 3 replications having 3 Planting method (Flat method, Furrow method and Ridge method) as main plot treatment, 6 organic manure levels (FYM 12.5 t/ha, FYM 25 t/ha, VC 2.1 t/ha, VC 4.2 t/ha, PM 2.1 t/ha and PM 4.2 t/ha) as sub plot treatment and 2 bio fertilizer levels (PSB 5 kg/ha and *Azospirillum* 5 kg/ha) as sub-sub plot treatment. The total treatment combination was 36. The onion variety Agrifound Dark Red was used for experimentation. The topography of the field was uniform with proper drainage system. The data of various parameters were recorded at different stages of plant growth and thereafter, tabulated and analyzed statistically by method of analysis of variance.

Results and Discussion

Quality attributes

The planting methods showed a significant influence on protein content during both the years and in pooled analysis (table 1). Ridge method of planting resulted in significantly highest protein content (6.32, 6.36 and 6.34%) over furrow method (5.91, 5.95 and 5.93%) and flat method (5.52, 5.38 and 5.45%) during 2013-14, 2014-15 and in pooled data, respectively. Total soluble solids in fresh bulb did not differ significantly due to effect of different methods of planting during both the years and in pooled analysis. However, ridge method of planting recorded numerically highest TSS *i.e.* 12.49, 12.54 and 12.52%, while lowest (12.29, 12.32 and 12.31%) value of TSS was observed in furrow method of planting during 2013-14, 2014-15 and in pooled data, respectively.

The application of organics also influenced the protein content and TSS significantly. Data in table 1 indicated that poultry manure application @ 4.2 t/ha showed the highest value of protein content (6.23%) followed by VC @4.2 t/ha (6.11%) and FYM 25.0 t/ha (6.06%). These results go along with nitrogen content of applied manures. The results are in agreement with those obtained by Adb-Elrazzang (2002) that increasing rate of seep and chicken manure, significantly increased nitrogen content of onion bulb.

The maximum TSS (12.72%) was recorded with S_4 (VC 4.2 t/ha) as well as S_2 (FYM 25.0 t/ha) followed by PM 4.2 t/ha (12.45%). Abou-Hussein *et al.* (2003) on potato found that application of chicken manure reduced the content of TSS as compared to other organic manures. The superior quality of onion under vermicompost treatments might be due to beneficial effect of organism which are brought about mucon deposited epidermal cell and coelomic cell of earthworm containing plant growth factor and B group vitamin. The effect of organic manure on quality parameters was also reported by Yeledhalli and Ravi (2008), Ghodia (2012) and Singh *et al.* (2015).

Bio-fertilizers did not show any significant influence on protein content during both the years and in pooled data. However, inoculation of seedlings with PSB @ 5 kg/ha resulted slightly higher protein content over inoculation of seedlings with *Azospirillum* @ 5 kg/ha during 2013-14, 2014-15 and in pooled data. Bio-fertilizers showed significant influence on TSS during both the years and in pooled data. Inoculation of seedlings with PSB @ 5 kg/ha resulted in significantly highest TSS over inoculation of seedlings with *Azospirillum* @ 5 kg/ha during 2013-14, 2014-15 and in pooled data. The TSS differed significantly due to bio-fertilizers while protein content remained unchanged due to bio-fertilizers. Seedlings inoculation with PSB resulted in significantly highest TSS (12.47%) as compared to seedlings inoculation with *Azospirillum* (12.31%). Tawfik (2008) stated that microbein, nitrobein and rhizobacterin are commercial bio-fertilizers which gave the same effect of full dose of mineral nitrogen application. The obtained results are in agreement with those obtained by Ghodia (2012).

Bulb yield

Bulb yield per hectare differed significantly due to method of planting. Seedlings transplanted on ridges resulted in significantly highest bulb yield (152.37 q/ha) over those transplanted in furrow and flat soils. The increases in bulb yield by ridge method over furrow and flat methods of planting were 9.09 and 35.45 per cent,

Table 1 : Bulb yield and Quality parameters of onion as influenced by planting methods, organic nutrient sources and bio-fertilizers.

Treatment	Protein content (%)			TSS (%)			Bulb yield (q/ha)		
	IY	IIY	Pooled	IY	IIY	Pooled	IY	IIY	Pooled
Planting Methods (P)									
P1: Flat method	5.52	5.38	5.45	12.33	12.37	12.35	111.37	113.60	112.49
P2: Furrow method	5.91	5.95	5.93	12.29	12.32	12.31	136.94	142.42	139.68
P3: Ridge method	6.32	6.36	6.34	12.49	12.54	12.52	150.86	153.88	152.37
CD (5%)	**0.28**	**0.29**	**0.16**	**NS**	**NS**	**NS**	**5.22**	**5.50**	**2.97**
Organics (S)									
S1: FYM 12.5 t/ha	5.64	5.62	5.63	12.01	12.05	12.03	126.68	130.08	128.38
S2: FYM 25.0 t/ha	6.07	6.04	6.06	12.70	12.74	12.72	136.47	140.14	138.31
S3: VC 2.1 t/ha	5.68	5.66	5.67	12.10	12.15	12.13	127.67	131.10	129.38
S4: VC 4.2 t/ha	6.12	6.09	6.11	12.69	12.74	12.72	137.63	141.33	139.48
S5: PM 2.1 t/ha	5.77	5.74	5.75	12.28	12.32	12.30	129.52	132.99	131.26
S6: PM 4.2 t/ha	6.24	6.21	6.23	12.43	12.47	12.45	140.37	144.15	142.26
CD (5%)	**0.11**	**0.12**	**0.08**	**0.15**	**0.17**	**0.10**	**1.82**	**1.90**	**1.28**
Bio-fertilizers (B)									
B1: PSB 5 kg/ha	5.93	5.88	5.90	12.45	12.49	12.47	134.55	138.17	136.36
B2: Azospirillum 5 kg/ha	5.91	5.91	5.91	12.29	12.33	12.31	131.56	135.10	133.33
CD (5%)	**NS**	**NS**	**NS**	**0.06**	**0.07**	**0.04**	**0.82**	**0.87**	**0.67**
Interaction									
P×S	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**Sig.**	**Sig.**	**Sig.**
P×B	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
S×B	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
P×S×B	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

respectively.

Hence, it is clear that yield of bulbs in quintals per hectare was the maximum with seedlings transplanted on ridges due to the highest weight per bulb, highest number of scales per bulb, maximum diameter of bulb and lowest bolting percentage. Similar effect of ridge planting method was also marked on growth factes as discussed earlier. Thus, there existed a positive correlation between growth and yield attributing characters. The similar results was also found in the work of Arian *et al.* (2004). However, these results are not in agreement with the findings of Shete *et al.* (2007) and Kanwar and Akbar (2013).

The yield of bulbs in quintals per hectare was the maximum at 4.2 t PM/ha due to the highest weight per bulb, highest number of scales per bulb, maximum diameter of bulb and lowest bolting percentage. Similar effect of increasing level of each organic and highest beneficial effect of 4.2 t PM/ha was also marked on growth facetes as discussed earlier. Thus, there existed a positive correlation between growth and yield attributing characters. At higher level of organics, improved soil physical conditions might have resulted in better root growth, nutrient absorption and better bulb development. Such response of poultry manure due to relatively high nutrient concentration and initial microbial population helped in mobilizing the unavailable pool of nutrients in soil, thereby triggering the acquisition of optimum nutrient supply across critical crop phenophases .Better growth of leaves/plant as effective nutrient sink of bulb, which eventually translated into higher yield.

The beneficial influence of organics on final bulb yield may be attributed to the efficiency of this factor in promoting vegetative activity in the plant. In fact, the final growth of an organism is the balance sheet of the two fundamental physiological processes, *viz*., anabolism and catabolism. Under favourable conditions for growth, anabolism exceeds catabolism, resulting in the storage of the various metabolities, which finally determine the degree and intensity of vegetative growth affecting the yield-attributes and bulb yield. A positive response to organics on onion in-terms of yield attributing characters and bulb yield was also reported by Mandloi *et al*. (2008), Yeledhalli and Ravi (2008), Ngullie *et al.* (2009), Lee

Table 2 : Interaction effect of planting methods and organic nutrient sources on bulb yield of onion.

Organics	Planting methods								
	2013-14			2014-15			Pooled		
	P1	P2	P3	P1	P2	P3	P1	P2	P3
	Bulb yield (q/ha)								
S1	106.91	129.79	143.35	109.05	134.99	146.22	107.98	132.39	144.78
S2	113.61	140.24	155.57	115.88	145.85	158.68	114.75	143.05	157.12
S3	107.75	130.81	144.46	109.91	136.04	147.35	108.83	133.42	145.90
S4	114.25	142.61	156.03	116.54	148.32	159.15	115.39	145.46	157.59
S5	109.28	132.47	146.82	111.46	137.77	149.75	110.37	135.12	148.28
S6	116.44	145.72	158.96	118.76	151.55	162.14	117.60	148.64	160.55
	$(P\times B)_1$		$(P\times B)_2$	$(P\times B)_1$		$(P\times B)_2$	$(P\times B)_1$		$(P\times B)_2$
CD (5%)	**3.15**		**5.91**	**3.29**		**6.20**	**2.21**		**3.59**

$(P\times B)_1$- Two organic nutrient sources at the same or different planting methods.
$(P\times B)_2$- Two planting methods at the same or different organic nutrient sources.

Jong Tae (2010), Bagali *et al*. (2012), Ghodia (2012), Yeptho *et al.* (2012) and Singh *et al.* (2015).

On examining the data of yield of bulb pertaining to bio-fertilizers in Table 1, it is clearly elucidated that PSB caused significant improvement in bulb yield over the production of bulb with Azospirillum. Increase in yield due to PSB inoculation could be attributed to increase in growth and yield attributing characters resulting from dissolution of insoluble phosphorus in soil to soluble forms and production of plant growth hormones and vitamins by microorganisms. The beneficial effect of bio-fertilizers was also reported by Ahmed (2009), Govindan *et al.* (2009) and Sharma *et al.* (2010).

The interaction of planting methods and organics in table 2. The maximum bulb yield (160.55 q/ha) was obtained from the treatment combination P3S6 (seedlings transplanted on ridges with 4.2 t PM/ha) followed P3S4 and P3S2. The improvement in bulb yield with the application of 4.2 t PM/ha under ridge planting method was owing to the beneficial effect of these on plant growth and analysis parameters and yield attributing components.

Economics

Seedlings inoculated with PSB transplanted on ridges with 4.2 t PM/ha ($P_3S_6B_1$) accrued the highest (table 3) gross monetary return amounting Rs. 161910/ha followed by P3S6B2 (Rs. 159200/ha), $P_3S_4B_1$ (Rs. 159020/ha) and $P_3S_2B_1$ (Rs. 158760/ha, whereas the minimum gross monetary return (Rs. 106520/ha) was under $P_1S_1B_2$ (Seedlings inoculated with *Azospirillum* transplanted in flat soils with 12.5 t FYM/ha). The gross income obtained from different treatments was in accordance with the onion yield received/ha.

The minimum net income of Rs. 26080/ha calculated when the *Azospirillum* inoculated seedlings transplanted in flat soils with 4.2 t PM/ha ($P_1S_6B_2$). On the other hand, seedlings inoculated with PSB transplanted on ridges with 25.0 t FYM/ha ($P_3S_2B_1$) accrued the highest net monetary return amounting Rs. 97060/ha followed by $P_3S_2B_2$ (Rs. 93790/ha) and $P_3S_1B_1$ (Rs. 91260/ha). The net income obtained from different treatment combinations of planting methods, organics and bio-fertilizers was in accordance with the onion yield received/ha and the expenditure incurred. The net income was obtained in the lower range when poultry manure was applied in different doses with any combination of planting methods and bio-fertilizers. This was owing to increased cost of poultry manure as compared to vermicompost and farm yard manure.

The highest B : C ratio of 2.65 was obtained with the treatment combination P3S1B1 closely followed by $P_3S_1B_2$ (2.58), $P_3S_2B_1$ (2.57) and $P_3S_2B_2$ (2.52). On the other hand, minimum B : C ratio of 1.29 was obtained with P1S6B2. The higher B : C ratio under treatment combination of FYM with ridge planting method and any bio-fertilizers was due to 32 to 39% less cost of cultivation as compared to poultry manure.

Conclusion

It was concluded that ridge method of planting resulted highest protein content (6.34%) and TSS (12.52%) as compare to furrow and flat method of planting. The interactions were found not significant response with these parameters. Seedlings inoculated with PSB transplanted on ridges with 25.0 t FYM/ha and PSB

Table 3 : Economics of the treatments.

Treatment	Bulb yield (q/h)			Mean total income (Rs./ha)	Mean total cost (Rs./ha)	Mean net income (Rs./ha)	B : C ratio
	IY	IIY	Pooled				
P1S1B1	108.36	110.52	109.44	109440	54700	54740	2.00
P1S1B2	105.46	107.57	106.52	106520	54700	51820	1.95
P1S2B1	114.82	117.11	115.96	115960	60950	55010	1.90
P1S2B2	112.40	114.65	113.53	113530	60950	52580	1.86
P1S3B1	109.20	111.38	110.29	110290	58950	51340	1.87
P1S3B2	106.31	108.43	107.37	107370	58950	48420	1.82
P1S4B1	115.44	117.75	116.59	116590	69450	47140	1.68
P1S4B2	113.06	115.32	114.19	114190	69450	44740	1.64
P1S5B1	110.60	112.82	111.71	111710	69450	42260	1.61
P1S5B2	107.95	110.11	109.03	109030	69450	39580	1.57
P1S6B1	117.50	119.85	118.67	118670	90450	28220	1.31
P1S6B2	115.37	117.68	116.53	116530	90450	26080	1.29
P2S1B1	131.53	136.79	134.16	134160	55450	78710	2.42
P2S1B2	128.06	133.18	130.62	130620	55450	75170	2.36
P2S2B1	141.71	147.38	144.54	144540	61700	82840	2.34
P2S2B2	138.78	144.33	141.55	141550	61700	79850	2.29
P2S3B1	132.54	137.84	135.19	135190	59700	75490	2.26
P2S3B2	129.07	134.23	131.65	131650	59700	71950	2.21
P2S4B1	144.07	149.83	146.95	146950	70200	76750	2.09
P2S4B2	141.16	146.80	143.98	143980	70200	73780	2.05
P2S5B1	134.06	139.42	136.74	136740	70200	66540	1.95
P2S5B2	130.88	136.12	133.50	133500	70200	63300	1.90
P2S6B1	147.03	152.91	149.97	149970	91200	58770	1.64
P2S6B2	144.42	150.19	147.30	147300	91200	56100	1.62
P3S1B1	145.26	148.16	146.71	146710	55450	91260	2.65
P3S1B2	141.44	144.27	142.85	142850	55450	87400	2.58
P3S2B1	157.19	160.33	158.76	158760	61700	97060	2.57
P3S2B2	153.95	157.03	155.49	155490	61700	93790	2.52
P3S3B1	146.36	149.29	147.82	147820	59700	88120	2.48
P3S3B2	142.55	145.41	143.98	143980	59700	84280	2.41
P3S4B1	157.44	160.59	159.02	159020	70200	88820	2.27
P3S4B2	154.61	157.70	156.16	156160	70200	85960	2.22
P3S5B1	148.56	151.53	150.05	150050	70200	79850	2.14
P3S5B2	145.07	147.97	146.52	146520	70200	76320	2.09
P3S6B1	160.31	163.51	161.91	161910	91200	70710	1.78
P3S6B2	157.62	160.77	159.20	159200	91200	68000	1.75

5 kg/ha accrued the highest net monetary return amounting Rs. 97060/ha followed by ridges with 25.0 t FYM/ha and PSB 5 kg/ha *Azospirillum* 5 kg/ha (Rs. 93790/ha) and $P_3S_1B_1$ (Rs. 91260/ha) while the highest B : C ratio of 2.65 was obtained with the treatment combination of ridge planting with 12.5 t FYM/ha and PSB 5 kg/ha closely followed by transplanted on ridges with 25.0 t FYM/ha and *Azospirillum* 5 kg/ha (2.58), $P_3S_2B_1$ (2.57) and $P_3S_2B_2$ (2.52).

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