Seed priming and nitrogen management on growth and yield of zero till sunflower (Helianthus annuus L.) succeeding rice.

ABSTRACT

Aim: To determine the effect ofseed priming and nitrogen management on growth, yield and economics of sunflower.

Study design: Split plot

Place and Duration of Study: Krishi Vigyan Kendra, Palem, between December 2021 and March 2022.

Methodology: A field experiment was conducted at Krishi Vigyan Kendra, Palem, Nagarkurnool (District) during *rabi* 2021-22 to assess the effect of seed priming and nitrogen management on growth and yield of zero till sunflower(*Helianthusannuus* L.) succeeding rice. The experiment was assigned in twelve treatments, laid out in split plot design with three replications. Treatments included were 4 treatments of seed priming methods (i) M_1 = Control (no priming) (ii) M_2 = Hydropriming (iii)M_3 = Osmopriming with KNO_3 @ 0.1%(iv) M_4 = Osmopriming with NaCl @ 0.1% and 3 nitrogen levels (i) S_1 = 100% RDN (ii) S_2 = 100% RDN (iii) S_3 = 150% RDN (RDN randomly placed in sub plots of the main plot.

Results: Significantly higher seed yield (1961 kg ha^{-1}), stalk yield (3562 kg ha^{-1}) was recorded under osmopriming with KNO_3 @ 0.1% (M_3). Similarly maximum seed yield (1944 kg ha^{-1}), stalk yield (3513 kg ha^{-1}) was observed in 150% RDN (S_3). The lower yield was recorded in M_1 in seed priming practices whereas it was S_1 (control) as in case of nitrogen levels. Exceptionally higher net returns was observed in M3 i.e osmopriming with KNO_3 (Rs.86401 ha^{-1}) and S_3i.e application of 150% RDN(Rs.84682 ha^{-1}).

Conclusion: Adoption of seed primingmethodsresults in higher plant stand and nitrogen levels increases the crop yield.

1. INTRODUCTION

Oilseeds occupy an important position in Indian agriculture being next to food grains as a farm commodity. Sunflower (Helianthus annuus L.) is one of the major oilseed crops of India. It has been described as "drenched with sun-vitality" because the head follows the sun, ending up facing the west "to absorb the few last rays for the dying sun" (Nagaraj, 1995). Moreover, sunflower has the potential to produce the highest oil yield per hectare and is also a good source of honey. Globally, sunflower covers 27.4 M .h a with the productivity of 2049 kg ha-1 whereas, India cultivates sunflower in 0.262 M. ha with productivity of 826 kg ha-1 in 2019-20 (FAO STAT 2019). India during 2019 imported around 15 Mt of edible oils (of which sunflower has 16% share next to palm oil and soya oil) worth approximately Rs. 7,300 crore, which accounted for 40 per cent of the agricultural imports bill and three per cent of the overall import bill of the country. Therefore, it is highly desirable to supplement our oilseeds production through the cultivation of sunflower.

Stand establishment is of primary importance for optimizing field production of any crop plant especially under conservation tillage. At suboptimal conditions of environment conditions, poor seed germination and subsequently poor field establishment is a common phenomenon. It has been reported that one of the major obstacles to high yield and production of crop plants is the lack of synchronized crop establishment due to poor weather and soil conditions (Mwale et. al., 2003). Strategies for improving the growth and development of crop species have been investigated for many years. Rapid germination and emergence are essential for successful crop establishment, for which seed priming could play an important role.

Heydecker (1973), defined 'Seed priming' as a pre-sowing seed treatment in which seeds are soaked in an osmotic solution that allows them to imbibe water and go through the first stages of germination but does not permit radical protrusion through seed coat. Rapid germination and emergence is an important factor of successful establishment. It is reported that the seed priming is one of the important developments to help rapid and uniform germination and emergence of seeds and to increase seed tolerance to adverse environmental conditions (Heydecker et al., 1975 and Harris et al., 1999). Seed priming is an effective technology to enhance rapid and uniform emergence and to achieve high vigour, leading to better stand establishment and yield. Seed priming is employed for better crop stand and higher yields in a range of crops.

Nitrogen is crucial for growth and development. The nitrogen requirement for sunflower is high. Oil content in sunflower seed is also affected by changes in the proportion of nitrogen. Nitrogen plays an important role in increasing the productivity of sunflower. Nitrogen is a major essential element and is responsible for increasing the photosynthetic surface area and in turn increases the translocation of phosynthates to sink and results in increase in productivity.

Conservation tillage systems improve land productivity by way of improved soil physical properties, reduced soil loss and enhanced soil organic carbon and greater retention of moisture and alters the soil C:N ratio there by initially reduces nitrogen availability to the crop plant. Information on response of sunflower crop to seed priming techniques and nitrogen management under conservation tillage needs to be generated for increasing the sunflower area and production during Rabi season for increased edible oil production.

2. MATERIAL AND METHODS

A field experiment was conducted during *rabi* season of 2021-22 at Krishi Vigyan Kendra, Palem, Nagarkurnool (District) with twelve treatments, laid out in split plot design with three replications. The soil of experimental site was sandy loam in texture and slightly alkaline in reaction (pH 8.04), with organic carbon (0.47%), available nitrogen (157 kg ha^{-1}), available phosphorus (30.5 kg ha^{-1}) and potassium (341 kg ha^{-1}) with electrical conductivity of 0.45 ds m^{-1}. Treatments included were 4 treatments of seed primingmethods (i) M_1 = Control (no priming) (ii) M_2 = Hydropriming (iii)M_3 = Osmopriming with KNO3 @0.1%(iv) M_4 = Osmopriming with NaCl @0.1% and 3 nitrogen management practices (i) S_1 = 100% RDN (ii) S_2 = 125% RDN (iii) S_3 = 150% RDN randomly placed in sub plots of the main plot. Sunflower hybrid 'DRSH-1' was sown in the field with a seed rate of 10 kg ha^{-1}, maintaining 45 cm x 20 cm as spacing at a depth of 2-3 cm. The crop was fertilized with 75:90:30 kg (100% RDF) of Nitrogen, Phosphorus and Potassium ha^{-1} in the form of Urea, DAP and MOP.

3. RESULTS AND DISCUSSIONS

3.1 Growth parameters

The data presented in (Table 1) shows theseed priming methods had shown significant difference among growth parameters of sunflower. The M_3 treatment recorded higher germination percentage (91.3), leaf area (2582 cm^2), initial population and final plant population (101407, 100518plants ha^{-1}) (The nitrogen management practices recorded significantly higher plant height and other crop growth parameters. The 150% RDN (S_3) had recorded significantly higher plant height at 30, 60 and 90 DAS. The maximum plant height at harvest was recorded in S_3(99.77 cm).Significantly higher germination percentage (91.2), leaf area (2575 cm^2 $plant^{-1}$)and dry matter production (5448kg ha^{-1})were observed in treatment S_3 which differed significantly with $S_2$and followed by 100% RDN. The control treatment recorded lowest growth attributes due to less availability of nutrients.Interaction effect of growth parameters of sunflower as influenced by main and sub treatments was found to be non significant at all crop growth stages. The higher nitrogen levels increases the higher photosynthetic area and growth attributes like plant height, leaf area and dry matter. Seed priming induced the higher germination percentage, seedling vigour index and germination index along with higher plant stand. Similar findings were observed byHussain *et al*. (2006) and Anwar *et al*. (2012).

3.2 Yield attributes and yield

The seed primingmethods recorded significantly higher seed yield and stalk yield (Table 3). The M_3 treatment showed significantly higher seed yield (1961 kg ha^{-1}) and stalk yield (3562 kg ha^{-1}). The maximum head diameter (16.4 cm), no. of seeds $head^{-1}$ (534) were observed in M_3 followed by M_4. Among nitrogen levels 150% RDN recorded significantly higher yield attributes and yield (seed and stalk). Significantly higherhead diameter (16.1 cm), no. of seeds $head^{-1}$(551),seed yield (1944 kg ha^{-1}) and stalk yield (3513 kg ha^{-1}) were recorded in 150% RDN (S3).

Seed yield and stalk yield of 150% RDN(S_3) is significant with 125% RDN(S_2) and lowest was recorded with 100% RDN (S_1).The interaction effect due to seed primingmethods and nitrogen management practices on yield attributes, seed yield and stalk yield of safflower was nonsignificant.Increased seed yield of sunflower was due to increase in final plant stand and yield attributes like head diameter, number of seeds $head^{-1}$and 1000 seed weight as observed in the present investigation. Increased Nitrogen availability increased the carbon assimilation, photosynthesis, canopy development (Massingam et al. 2003) and increased dry matter production and its better partitioning resulted in improvement of yield attributing characters, culminating in higher seed yield and stalk yield which was clearly observed in case of S_3. Similar findings were also reported by Khaliq *et al*. (2004).

3.3 Harvest index

The data presented in (Table 2) visualize that the seed primingmethodsand nitrogen management practices have conspicuous effect on harvest index.Significantly higher harvest index was noted with M_4 and lower harvest index with M_3. A higher harvest index was observed in case of 100% RDN (S_1) (32.75) followed by 125% RDN (S_2) whereas the lowest with 150% RDN (S_3).

3.4 Economics

The data regarding gross returns, net returns and returns per rupee investment of zero tillage sunflower as influenced by seed priming and nitrogen management was represented in Table 3.

Maximum gross returns (119765 Rs. ha^{-1}) was realized for the treatment M_3 (osmopriming with KNO_3 @0.1%) and S_3(118285 Rs. ha^{-1}) (application of 150% RDN) and lowest gross returns was recorded under M_1 (control) (98070 Rs. ha^{-1}) and S_1 (100% RDN) (100774 Rs.ha^{-1}). The same trend was reflected in net returns and returns per rupee investment. Osmopriming with KNO_3 and application of 150% RDN contributed to higher seed yield and as it is practiced under zero tillage conditions which lead to low cost of cultivation inturn resulted in higher gross returns, net returns and returns per rupee investment as compared to other treatments. Similar reports were recorded by Narayana and Patel (2002) and Singh *et al*. (2007)

Table 1. Growth parameters of sunflower as influenced by seed priming methods and nitrogen levels.

Treatment	Germination percentage	Time to 50% seedling emergence	Initial plant population	Final plant population
		Seed priming		
M_1-Control	88.222	4.67**(c)**	98,024.660 (c)	96,913.550 (c)
M_2-Hydropriming	89.178	4.11 (b)	99,086.450 (b)	98,530.890 (b)
M_3-Osmopriming (0.1% KNO_3	91.267	3.00 (a)	101,407.300**(a)**	100,518.400 (a)
M_4-Osmopriming (0.1% NaCl	89.456	3.33 (b)	99,395.0 **(b)**	98950.55 (b)
SE(m)	0.234	0.10	356.087	237.759
CD(P=0.05)	0.827	0.33	914.253	838.748
		Nitrogen levels(kg ha^{-1})		
S_1-100% RDN	88.0 (c)	3.92	97,777.66 (c)	97,027.66 (c)
S_2-125% RDN	89.383 (b)	3.83	99,314.910 (b)	98,648.250 (b)
S_3-150% RDN	91.208 (a)	3.58	101,342.500 (a)	100,509.2 (a)
SE(m)	0.281	0.15	312.759	245.76
CD(P=0.05)	0.851	NS	945.725	743.133
		Interaction		
SE(m)	0.406	0.30	572.725	411.811
CD(P=0.05)	NS	NS	NS	NS

Table 2.Growth parametersof sunflower as influenced by seed priming methods and nitrogen levels.

Treatment	Plant height (cm)			Leaf area (cm^2)			Dry matter accumulation		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
Seed priming methods									
M_1	34.2	102.5	147.0	1334	2344	1682	628	3288	4674
M_2	36.6	106.6	156.1	1387	2472	1760	768	3497	5167
M_3	37.6	113.1	163.6	1470	2582	1872	942	3763	5448
M_4	36.7	110.9	157.6	1417	2503	1812	802	3527	5159
SEm±	0.3	0.7	3.2	15	17	17	27	57	82
CD (P=0.05)	0.9	2.0	NS	52	61	59	96	201	284
Nitrogen levels									
S_1	34.1	101.4	141.1	1341	2398	1716	658	3067	4726
S_2	36.4	109.6	157.4	1389	2452	1762	804	3594	5156

S_3	38.3	113.8	169.8	1475	2575	1857	894	3896	5454
SEm±	0.7	1.2	2.6	10	18	10	19	100	73
CD (P=0.05)	2.1	3.6	7.7	29	53	29	59	300	217
Interaction									
SEm±	0.2	2.4	5.1	22	32	23	42	173	148
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: cm- centimeter, DAS-Days after sowing, NS- Non significant

Table 3.Effect ofseed priming methods and nitrogenlevelson yield attributes and yield of sunflower.

Treatments	Head diameter (cm)	No. of filled seeds head^{-1}	1000 seed weight (g)	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	Harvest index (%)	Threshing percentage	Oil content
Seed priming methods								
M_1	13.3	506	39.27	1654	3101	34.7	75.0	42.08
M_2	14.6	522	39.54	1857	3364	35.6	76.9	42.44
M_3	16.4	534	41.20	1961	3562	35.5	79.0	43.09
M_4	15.2	523	40.78	1867	3373	35.7	77.1	42.88
SEm±	0.3	3	0.50	25	69.1	0.3	0.5	0.41
CD (P=0.05)	1.1	9	NS	87	239	0.8	1.8	NS
Nitrogen levels								
S_1	13.7	492	39.88	1724	3204	35.0	74.6	42.32
S_2	14.7	521	40.29	1837	3333	35.5	76.8	42.47
S_3	16.1	551	40.42	1944	3513	35.6	79.7	43.09
SEm±	0.2	4	0.40	31	51	0.2	0.3	0.27
CD (P=0.05)	0.7	12	NS	93	152	0.5	0.8	NS
Interaction								
SEm±	0.5	8	0.76	56	108	0.8	0.7	0.6
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Table 4. Effect ofseed priming methods and nitrogen levels on economics of sunflower.

Treatments	Gross returns	Net returns	Returns per rupee investment
Seed priming methods			
M_1	98070	64716	1.94
M_2	108239	74885	2.24
M_3	119765	86401	2.59
M_4	108972	75610	2.27
Nitrogen levels			
S_1	100774	67660	2.04
S_2	107225	73867	2.21
S_3	118285	84682	2.52

4. CONCLUSION

Comparing osmopriming with KNO_3 to other seed priming techniques, it can be said that osmopriming with KNO_3 and application of 150% RDN was more cost-effective in obtaining better seed yields and high net returns. Osmopriming with 0.1% KNO_3ensures sunflower production in areas where zero tillage is practiced and frequent crop failure are normal occurrences.

REFERENCES

1. Basra SMA, Farooq M, Tabassam R, Ahmad N (2005) Physiological and biochemical aspects of pre-sowing seed treatments in fine rice (*Oryza sativa* L.). Seed Sci Technol 33(3):623–628.
2. FAOSTAT, 2019. https://www.fao.org/faostat/en/#data/QCL
3. Harris, D., Joshi, A., Khan, P. A., Gothkar, P. and Sodhi, P. S. 1999. On-farm seed priming in semi-arid agriculture: development and evaluation in maize, rice and chickpea in India using participatory methods. Exp. Agric. 35: 15-29.
4. Hussain, M., Farooq, M., Basra, S. M., & Ahmad, N. (2006). Influence of seed priming techniques on the seedling establishment, yield and quality of hybrid sunflower. *International Journal of Agriculture and Biology*, 8(1), 14-18.
5. Khaliq, A. (2004). Irrigation and nitrogen management effects on productivity of hybrid sunflower (*Helianthus annuus* L.). *Unpublished Ph. D. Agronomy Thesis, University of Agriculture, Faisalabad*.
6. Mwale, S. S., Hamusimbi, C. and Mwansa, K. 2003. Germination, emergence and growth of sunflower (*Helianthus annuus* L.) in response to osmotic seed priming. *Seed Sci. Technol*. 31:199-206.
7. Nagaraj, G. 1995. Quality and Utility of Oilseeds. Directorate of Oilseeds Research, Indian Council of Agricultural Research, Hyderabad, India
8. Narayana, E and Patel, S.C. 2002. Yield and economics of sunflower as influenced by irrigation and fertilizers in South Gujarat. *Journal of Oilseeds Research*. 17: 110-112.
9. Sedghi M, Ali N, Esmaielpour B (2010) Effect of seed priming on germination and seedling growth of two medicinal plants under salinity. *J Emir Food Agric* 22:130–113.
10. Singh, J.K. 2007. Response of sunflower and French bean intercropping to different row ratios and sunflower levels under rainfed conditions of temperate Kashmir. *Indian Journal of Agronomy*. 52 (1): 36-39.