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Weed management in soybean (*Glycine max* L. Merrill) under varied weather conditions

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Abstract
An experiment on weed management in soybean (*Glycine max* L. Merrill) under varied weather conditions was carried out during the *Kharif* season of 2021-22 at experimental Farm, Department of Agronomy, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (M.S). The experiment was laid out in Split Plot Design with three replications and twelve treatments combination of The main plot treatments consisted of three dates of sowing D_1 (26 MW), D_2 (28 MW), D_3 (30 MW) and subplot consisted of four weed management practices *viz.* W_1 (PE Sulfentrazone 28%+ Clomazone 30% @ 350+375 g a.i/ha),W_2 (PoE Propaquizafop 2.5% + Imazethapyr 3.75% @ 50+75 g a.i/ha), W_3 (1Hand Weeding+1 Hoeing) and W_4 (Unweeded control). The lowest weed dry weight (g) for both monocot and dicot weeds were found in D_3 (30 MW) at 30 and 45 days after sowing. Among weed management practices in soybean, W_1 (PE Sulfentrazone 28%+Clomazone 30% @ 350+375 g a.i/ha) followed by W_2 (PoE Propaquizafop 2.5% + Imazethapyr 3.75% @ 50+75 g a.i/ha) were found most effective in controlling weeds recording lowest weed dry matter. These treatments were comparable to W_3 (1Hand Weeding +1 Hoeing) and found significantly superior over other treatments. Seed yield ,straw yield and biological yield of soybean was obtained significantly higher in W_3 (1Hand Weeding +1 Hoeing) treatment but was at par with W_1 (PE Sulfentrazone 28%+ Clomazone 30% @ 350+375 g a.i/ha) followed by W_2 (PoE Propaquizafop 2.5% + Imazethapyr 3.75% @ 50+75 g a.i/ha).

Keywords: Weed management, soybean, weed control, pre-emergence herbicide, post-emergence herbicides and weather parameters, dates of sowing

Introduction
Weeds cause 10 to 80% crop yield losses besides deteriorating quality of products and causing health and environmental hazards (Paswan *et al*., 2017) [9]. They use the available moisture, nutrients and compete for space & sunlight with the crops plants which result in yield reduction. Weeds provide shelter and acts as an alternate host for pests (Marwat *et al*., 2005) [8]. The most problematic weeds in soybean *viz*., *Amaranthus viridis* L., *Phyllanthus niruri* L, *Digera arvensis* Forsk, *Cynodon dactylon* (L) Pers, *Echinochloa colonum*(L) Link.. For sustaining food grain production to feed ever-increasing population and ensuring food security, effective weed management is very essential. (Singh *et al.* 1993) [11].
Sowing date play an important role in determining the occurrence of weed biomass in soybean field. The effect of soybean planting date on weed population found that delaying soybean planting from mid- May too early – June reduced weed densities and yield losses from weed (Buhler and Gusolus, 1996) [2]. Barmuda grass dominated at early period that is before mid – January whereas population intensity of prostate false pimpernel was increased up to the end period (Mid –January to April) of the experiment (Akter *et al.* 2016) [1]. In *Kharif* season, the weed competition is one of the most important cause of low yield, which estimated to be 31-84%. (Kachroo *et al.*, 2003) [6]. Also there is need to test the efficacy of different newly released broad spectrum pre-emergence and post emergence herbicides in soybean. Considering these points this experiment was carried out.

Materials and Methods
Field experiment entitled on weed management in soybean (*Glycine max* L. Merrill) under varied weather conditions was carried out on black soil during the *Kharif* season of 2021-22 at Experimental Farm, Department of Agronomy, College of Agriculture, and V.N.M.K.V Parbhani. The topography of the experimental plot was well uniform and levelled. The soil was deep and fairly well drained. The experiment was laid out in Split Plot Design with 3 replications and 12 treatments combination of three dates of sowing D_1 (26 MW), D_2 (28 MW),

D_3 (30 MW) in main plot and subplot consisted of four weed management practices W_1 (PE Sulfentrazone 28%+ Clomazone 30% @ 350+375 g a.i/ha), W_2 (P_OE Propaquizafop 2.5% + Imazethapyr 3.75% @ 50+75 g a.i/ha). W_3 (1 Hand Weeding +1 Hoeing), W_4 (Unweeded control). The size of the gross and net plot was 5.4m x 4.5m and 4.5m x 4.2m respectively. The sowing was done as per treatments on 30/6/2021 (D_1), 15/7/2021(D_2) and 29/72021 (D_3) respectively. An area of a quadrate 1 $m^2$was fixed in each experimental plot and observations on weed count were recorded at different stages. These weed samples were sun-dried for three days and then oven dried at 70 °C in oven to keep a consistent weight.

Results and Discussion

Weed dry matter (g)

Data on dry weed weight of monocot and dicot weeds in g m^{-2} at 15, 30 and 45 DAS as influenced by different treatments are presented in Table 1

Effect of sowing dates

Data on weed dry matter as influenced by different treatments is presented in Table 1. At 15 DAS among three different dates of sowing, D_3 (30 MW) recorded comparatively lower weed dry matter for monocot and dicot weed compared to early sowing date i.e. D_2 (28 MW) and D_1 (26 MW). At 30, 45 DAS similar result was recorded by different dates of sowing.

The well distribution of rainfall during growing period of D_1 (26 MW) observed during growth stages resulted in maximum weed count which tend to increase the total weed dry matter. The lowest weed count was observed in third date of sowing D_3 (30 MW) *i.e* delayed sowing which recorded lowest weed dry matter. Similar findings were recorded by Buhler and Gusolus (1996) [2].

Effect of weed management practices

The data presented in table 2 showed that weed dry matter was significantly influenced by various weed management practices at all growth stages.

The treatment W_3 (1 Hand Weeding +1 Hoeing) recorded significantly lower weed dry matter for monocot and dicot weeds over rest of treatments and was at par with W_1 (PE Sulfentrazone 28%+ Clomazone 30% WP@350+375 g ai/ha) at 15 and 45 DAS while it was at par with W_2 (P_OE Propaquizafop 2.5% +Imazethapyr 3.75% @50+75 g a.i/ha) at 30 DAS. The highest weed dry matter for monocot and dicot was recorded by W_4 (Unweeded Control).

Dry weed weight for both monocot and dicot weeds were recorded lowest in W_3 (1 Hand Weeding +1 Hoeing) and treatments with pre-emergence herbicides with hand weeding in combination which was significantly lower than rest of the weed management practices it might be due to better weed control under these treatments which resulted in reduced weed dry weight. Similar results were recorded by Prachand *et al.* (2015) [10] and Thakare *et al.* (2015) [13].

Interaction Effect

The interaction effect between date of sowing and weed control treatment was found to be non-significant.

Soybean seed yield (kg/ha^{-1})

Data regarding the seed yield (kg/ha^{-1}) of soybean as influenced by different treatments is presented in Table 2. The treatments differences of seed yield of soybean due to different treatments were found significant.

Effect of sowing dates

The data presented in Table 2 and revealed that the seed yield of soybean was significantly influenced by different sowing dates. From three different dates of sowing, D_1 (26 MW) recorded maximum seed yield ha^{-1} and was significantly superior over D_2 (28 MW) and D_3 (30 MW) respectively. The crop sown on D_1 (26 MW) produced maximum seed yield ha^{-1} (1841 Kg/ha^{-1}) which was significantly superior over rest of sowing dates and lowest at D_2 (28 MW) and D_3 (30 MW) respectively. The probable reason for this may be the suitable all the weather parameters and highest yield contributing character of D_1 (26 MW).Similar results were also reported by Toum *et al*. (2020) [5].

Effect of weed management practices

Regarding different weed management practices, W_3 (1 Hand Weeding+1 Hoeing) recorded significantly maximum seed yield ha^{-1} (1708 kg/ha^{-1}) except treatments W_1 (PE Sulfentrazone 28%+ Clomazone 30% @ 350+375 g a.i/ha) (1573 kg/ha^{-1}) and was found to be at par with W_2 (P_OE Propaquizafop 2.5%+Imazethapyr 3.75% 50+75 g ai/ha) (1404 kg/ha^{-1}). The lowest seed yield was recorded (982 kg/ha^{-1}) with W_4 (Unweeded Control). Similar results were also reported by Bhalla *et al*. (1998) [4].

Effect of interaction

The interaction effect of treatments on seed yield (kg/ha^{-1}) of soybean could not reach to the level of significance.

Table 1: Mean dry weed weight (g m^{-2}) as influenced by different treatments at 15, 30 and 45 days after sowing

Treatments	15 DAS		30 DAS		45 DAS	
	Monocot	Dicot	Monocot	Dicot	Monocot	Dicot
Dates of sowing						
D_1: (26 MW)	8.18 *(3.02)	6.91 (2.81)	7.36 (2.89)	7.09 (2.84)	9.69 (3.26)	9.09 (3.17)
D_2: (28 MW)	7.25 (2.87)	6.50 (2.73)	6.61 (2.75)	6.13 (2.67)	8.90 (3.14)	8.17 (3.02)
D_3: (30 MW)	6.41 (2.72)	5.84 (2.61)	6.16 (2.67)	5.12 (2.47)	7.98 (2.99)	7.25 (2.87)
S.E. ±	0.08	0.09	0.17	0.21	0.31	0.15
CD at 5%	0.34	0.38	0.66	0.85	1.21	0.61
Weed management practices						
W_1 : (PE Sulfentrazone 28%+Clomazone 30% @ 350+375 g ai/ha)	4.60 (2.36)	3.46 (2.11)	6.08 (2.66)	5.67 (2.58)	6.83 (2.79)	5.96 (2.63)

W_2 : (P_OE Propaquizafop 2.5% + Imazethapyr 3.75% @ 50+75 g a.i/ha)	8.03 (3.00)	6.93 (2.81)	4.74 (2.39)	3.82 (2.19)	8.12 (3.01)	7.50 (2.91)
W_3 : (1Hand Weeding +1Hoeing)	7.01 (2.83)	6.51 (2.74)	4.00 (2.23)	3.12 (2.02)	5.98 (2.64)	4.90 (2.42)
W_4 : (Unweeded control)	9.50 (3.24)	8.77 (3.12)	12.03 (3.60)	11.84 (3.58)	14.48 (3.93)	14.33 (3.91)
S.Em.±	0.19	0.24	0.25	0.23	0.29	0.35
C.D at 5%	0.58	0.73	0.74	0.69	0.87	1.06
Interaction effect (DXW)						
S.Em.±	0.33	0.43	0.43	0.40	0.50	0.62
C.D at 5%	NS	NS	NS	NS	NS	NS
G.M	7.28	6.42	6.716	6.11	8.85	8.17

*The value in parenthesis are transformed by $\sqrt{x}$+1

Table 2: Seed yield (kg/ha^{-1}), Straw yield (kg/ha^{-1}), and biological yield (kg/ha^{-1}) as influenced by different treatments in soybean

Treatments	Seed yield (Kg ha^{1})	Straw yield (kg/ha^{-1})	Biological yield (kg/ha^{-1})	Weed Index (%)
Dates of sowing				
D_1: (26 MW)	1841	2710	4552	-
D_2: (28 MW)	1314	2099	3414	-
D_3:(30 MW)	1095	1902	2997	-
S.Em.±	37.21	15.61	50.29	
C.D at 5%	146.10	61.31	197.46	
Weed management practices				
W_1 : (PE Sulfentrazone 28%+Clomazone 30% @ 350+375 g ai/ha)	1573	2284	3858	7.50
W_2 : (P_OE Propaquizafop 2.5% + Imazethapyr 3.75% @ 50+75 g a.i/ha)	1404	2208	3612	18.90
W_3: (1Hand Weeding +1 Hoeing)	1708	2504	4212	-
W_4 : (Unweeded control)	982	1952	2935	44.34
S.Em.±	45.08	73.74	109.28	
C.D at 5%	133.96	219.10	324.71	
Interaction effect (DXW)				
S.Em.±	78.09	127.72	189.28	
C.D at 5%	NS	NS	NS	
G.M	1417	2237	3654	23.58

Soybean straw yield (kg/ha^{-1}) and biological yield (kg/ha^{-1})

Data regarding the mean straw yield (kg/ha^{-1}) and biological yield (kg/ha^{-1}) of soybean as influenced by different treatments is presented in Table 2. The differences in straw yield and biological yield (kgha^{-1}) of soybean due to various treatments were found significant.

Effect of sowing dates

The data presented in Table 2 revealed that the straw yield and biological yield (kg/ha^{-1}) of soybean was significantly influenced by different sowing dates. From three different dates of sowing, D_1 (26 MW) recorded maximum straw and biological yield (kgha^{-1}) was significantly superior over late dates of sowing and it was lowest with D_3 (30 MW) respectively. The crop sown on D_1 (26 MW) produced maximum straw yield ha^{-1} and biological yield (kgha^{-1}) which was significantly superior over rest of sowing dates and lowest at D_3 (30 MW) respectively. The probable reason for this may be the suitability of all the weather parameters and highest growth yield contributing character of D_1 (26 MW).Similar results were also reported by Khan *et al.* (2020) [7] and Barati *et al.* (2012) [3].

Effect of weed management practices

From different weed management practices, W_3 (1Hand Weeding +1 Hoeing) recorded significantly maximum straw yield ha^{-1} and biological yield (kgha^{-1}) over rest of treatments and at par with W_1 (PE Sulfentrazone 28%+ Clomazone 30% @ 350+375 g a.i/ha). Treatment (W_1) found to be at par with W_2 (P_OE Propaquizafop 2.5% +Imazethapyr 3.75% 50+75 g ai ha^{-1}). The lowest straw yield and biological yield (kg/ha^{-1}) was recorded with W_4 (Unweeded Control). These results are in line with the findings reported by Singh *et al* (2004) [12].

Effect of interaction

The interaction effect could not reach to the level of significance in influencing the straw yield (kg/ha^{-1}) and biological yield (kg/ha^{-1}) of soybean.

Weed index

The data pertaining to weed index computed on the basis of maximum seed yield recorded with treatment W_3 (1Hand Weeding +1 Hoeing) and presented in Table 2. Minimum yield reduction was observed with W_1(PE Sulfentrazone 28%+ Clomazone 30% @350+375 g ai/ha) followed by W_2 (P_OE Propaquizafop 2.5% + Imazethapyr 3.75% @ 50+75 g a.i/ha). The data indicated that highest weed index was recorded with treatment W_4 (Unweeded Control) resulted in yield loss to the extent of 44.34%. Similar results were reported by Thakare *et al*. (2015) [13].

The lower is the weed index in chemical treatments, better the efficiency of the herbicide in controlling weeds, which provided favourable condition for crop growth which ultimately increased the seed yield of soybean crop as compared to W_4 (Unweeded Control) treatment.

Conclusion

From one year experiment on weed management in soybean carried out during *Kharif* season 2021-22 at Department of Agronomy, Vasantrao Naik Marathwada Krishi Vidyapeeth,

Parbhani, it can be concluded that.

1) Among the three dates of sowing in soybean D_1: (26 MW) was found productive and profitable for improving growth and yield of soybean as compared to late sowing dates *viz.* D_2 (28 MW) and D_3 (30 MW).
2) From the different weed management practices Pre emergence Sulfentrazone 28% + Clomazone 30% @ 350+375 g a.i/ha was found efficient in controlling monocot and dicot weeds in soybean as well as highly productive, remunerative and was comparable with W_3 (1 Hand Weeding +1 Hoeing) over the other treatments.

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