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Research Paper

Crop-weed competition in *Napier Bajra* hybrid (*Pennisetum purpureum* × *Pennisetum glaucum*) under different planting materials

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ABSTRACT

A field experiment was conducted to find out critical period of crop-weed competition and to determine the extent of green fodder yield loss in Napier Bajra hybrid (*Pennisetum purpureum* × *Pennisetum glaucum*) at forage research farm, Ludhiana, Punjab, during 2014 and 2015. The experiment was laid out in split-plot design, keeping two planting materials (rooted slips and stem cuttings) in main plot and weed-infestation durations (weed infested till initial 10, 20, 30, 40 and 60 days after planting and weed-free for initial 10, 20, 30, 40 and 60 days after planting) in subplot. Rooted slips recorded significantly higher green fodder yield than stem cutting. The higher fodder yield with rooted slips might be owing to more vigorous plant growth at early stage. The reduction in fodder yield in the control (weedy check) was 43.2% as compared to weed-free conditions. The critical period of crop-weed competition was found to be 10–30 days after planting on the basis of different weed-infestation durations. Gompertz and logistic equations fitted to yield data in response to increasing period of weed control and weed interference showed that rooted slips (4–32 days) had longer critical period that stem cutting (5–27 days). Critical weed-free period for rooted slips planting was more than stem planting by 6 days during both years. However, Napier Bajra hybrid planted with rooted slips significantly overcome the weed pressure than stem cutting during both years.

Key words: Critical period, Green fodder yield, Napier Bajra hybrid, Planting material, Weed competition

Cultivation of green fodder is being practiced by most of livestock farmers in Punjab and major fodder crops grown in the state are berseem, maize, sorghum and oats. However, farmers are facing the difficulty to ensure green fodder supply year round which paved the way for developing perennial Napier Bajra hybrid. Napier Bajra hybrid is erect growing, palatable and nutritious fodder plant. This crop is sown at wider row spacing and as a result weeds grow profusely and weeds pose competition to crop plants for natural resources. There is an acute crop-weed competition during the early stages of crop because of slow initial growth and weeds grow at a faster pace. Weeds not only deter the crop growth by creating crop-weed competition for available resources but also cause serious losses in terms of yield, declining the quality of produce and harbour many associated disease causing pathogens and pests.

For successful weed management and to alleviate harmful effects of weeds on crop yield, the identification of critical period of weed control is must.

Determining the critical period of weed control could help in reducing yield losses due to weed interference. So, the critical period of weed control could be used to enhance the efficacy of other methods of weed management. It is useful in making decisions on need and timing of weed control which is important in maintaining optimum crop yield. Research work on the critical period of crop-weed completion in Napier Bajra hybrid is lacking in India. Hence a study was planned to find out critical period of crop-weed competition and to evaluate its effects on the green fodder yield in Napier Bajra hybrid.

MATERIALS AND METHODS

A field experiment was conducted to assess the critical period of crop-weed competition in Napier Bajra hybrid at Forage Research Farm, Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana, (30°56' N, 75°52' E, 247 meter above the mean sea-level). during the rainy (*kharif*) season of 2014 and 2015. The soil was loamy sand with *p*H (7.8), normal in electrical conductivity (0.21dS/m), low in organic carbon (0.35%), available nitrogen (218.7 kg/ha), medium in available

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phosphorus (19.4 kg/ha) and high in available potassium (330 kg/ha). The experiment was laid out in a split-plot design, keeping 2 planting material (rooted slips and stem cuttings) in main plot and 10 periods of weed interference (weed infested till initial 10, 20,30, 40 and 60 days after planting (DAP) and weed-free for initial 10, 20, 30, 40 and 60 DAP) in subplot. The planting of Napier Bajra hybrid 'PBN 233' was done in the last week of March 2014 and 2015. Approximately 27,500 root slips and stem cuttings/ha were planted at spacing of 60 cm × 60 cm apart in lines. Weed-free conditions were maintained as per treatments. In weedy plots, no weeding was practiced and in weed-free plots, complete weed removal was done through hand-weeding. In all other weedy treatments (weedy up to 10, 20, 30, 40 and 60 DAP), the weeds were allowed to grow up to the respective days, thereafter, complete weed removal was practiced. In other treatments with certain weed-free periods (weed-free up to 10, 20, 30, 40 and 60 DAP), the weeds were completely removed from the plot up to the respective days and there after weeds were allowed to grow freely. All other cultural practices were uniformly applied to crop. The crop was raised with recommended practices for Napier Bajra hybrid. Samples for weed count was measured from two quadrats of 50 cm × 50 cm by harvesting weeds at the ground level in each plot at harvesting and before each weed removal for the weed-free and the weedy treatments respectively. After drying the weed samples at 70°C in an oven for 72 h, weed biomass (grasses, broad-leaf and sedges) was obtained. The first cutting of crop was taken 60 days after planting during both the years. Data on weed count and weed dry weight were subjected to square-root transformation to normalize their distribution. The Gompertz equation was used to describe the effect of increasing duration of weed-free period on green fodder yield of Napier Bajra hybrid. A logistic equation was used to describe the effect of increasing lengths of weed-infested period on the green fodder yield of crop. To calculate the beginning and end of the critical period, yield loss of 5% was chosen. The data for individual year were pooled and statistically analysed as per split plot design (SAS, 9.3).

RESULTS AND DISCUSSION

Green fodder yield

Planting materials and weed-infestation durations significantly influenced green fodder yield of Napier Bajra hybrid (Table 1). Rooted slips recorded significantly higher green fodder yield over stem cutting during both the years. This might owing to the already established root-system in crop planted through root slips which starts function early to absorb moisture and nutrients from soil immediately after planting as compared to stem cuttings because planting through stem cuttings required certain time for establishment of roots. These results are in agreement with findings of Pathan *et al*. (2007).

In case of weed-infestation durations, significantly higher green fodder yield of 48.6 t/ha was observed in crop kept weed-free till harvesting which was at par with the crop kept weed-free up to 40 DAP and weedy thereafter, weedy up to 10 DAP and weed-free thereafter and weed-free up to 30 DAP and weedy thereafter. Due to elimination of weeds, the crop under weed-free plots attained lush growth resulted in superior yield attributes and development and ultimately the highest fodder yield. The lowest fodder yield was observed in weedy check plots and it was comparable with that of weedy up to 30 DAP and then weed-free, weedy up to 40 DAP and then weed-free. The maintenance of weed-free condition for first 30 DAP resulted in significantly higher fodder yield than plots where weeds were allowed to grow for first 30 days and weed-free thereafter. The weed-free conditions between 10 and 30 DAP significantly increased the yield of crop, whereas the minimum yield was recorded when weeds were allowed to grow during this period (Table 1). The results are in conformity with Rao *et al*. (2007) and Sanodiya *et al*. (2013). The yield loss was 43.2% in plots where weeds were kept throughout the growing period as compared to weed-free plots.

Weed-control efficiency and weed index

Mean data over 2 years (Table 1) showed that highest weed-control efficiency (91.9%) was obtained when the crop was kept weed-free up to 40 DAP and weedy thereafter, followed by weedy up to 10 DAP and weed-free thereafter (85.5 %). Weed index varied from 1.81 to 43.2% during the study. The long duration of weed infestation in weedy check resulted in higher weed index (43.2%) which was closely followed by crop kept weedy for 40 days, weedy for 30 days and weed-free for 10 days. The losses caused by weeds increased linearly with the increased weed-infestation duration from 10 to 40 days and decreased with the increased weed-free duration as reflected by weed index. Similar result of the maximum yield loss of 49.5% was reported under weedy check where weeds were not controlled in the entire crop season (Sharma and Chander, 2006).

Critical period of crop-weed competition

According to Gompertz equation, the duration of weed-free period was more in root planting and the logistic equation explained that length of period up to which weeds could remain in field is less in root planting. By superimposing both the curves, planting material of root slips required longer weed-free period of 4–32 days and

Table 1. Effect of planting material and weed infestation durations on weed biomass and green fodder yield in Napier Bajra hybrid (mean data over 2 years)

Treatment	Weed biomass* (g/m^2)				Weed-control efficiency (%)	Weed index	Green fodder yield (t/ha)
	Grasses	Broadleaf	Sedges	Total			
Planting material							
Root slips	7.14 (62)	6.16 (45)	3.26 (11)	9.85 (118)	49.8	-	42.6
Stem cuttings	7.42 (67)	6.48 (50)	3.42 (12)	10.3 (129)	45.1	-	36.1
SEm±	0.06	0.05	0.04	0.06	-	-	0.47
CD (P=0.05)	0.19	0.15	0.11	0.19	-	-	1.41
Weed-infestation durations							
Weedy up to 10 days after planting (DAP) and weed-free thereafter	4.10 (16)	3.15 (9)	3.05 (9)	5.85 (34)	85.5	3.14	47.1
Weedy up to 20 DAP and weed-free thereafter	7.39 (54)	7.21 (51)	3.72 (14)	10.9 (119)	49.4	18.5	39.6
Weedy up to 30 DAP and weed free thereafter	10.7 (113)	9.12 (83)	4.28 (17)	14.6 (213)	9.36	37.0	30.6
Weedy up to 40 DAP and weed free thereafter	11.2 (124)	9.30 (86)	4.39 (19)	15.1 (229)	2.55	38.5	29.9
Weed-free to 10 DAP and weedy thereafter	10.9 (116)	9.03 (81)	4.14 (17)	14.7 (214)	8.94	27.6	35.2
Weed-free to 20 DAP and weedy thereafter	6.63 (43)	6.24 (38)	3.42 (11)	9.64 (92)	60.9	15.4	41.1
Weed-free to 30 DAP and weedy thereafter	6.42 (40)	5.92 (34)	3.21 (10)	9.21 (84)	64.3	5.82	45.8
Weed-free to 40 DAP and weedy thereafter	3.21 (10)	2.83 (7)	1.80 (2)	4.44 (19)	91.9	1.81	47.7
Weedy up to 60 DAP i.e (Ist cutting) (weedy check)	11.3 (128)	9.39 (88)	4.41 (19)	15.3 (235)	-	43.2	27.6
Weed-free to 60 DAP (Ist cutting) (weed free check)	1.00(0)	1.00 (0)	1.00 (0)	1.00 (0)	100	-	48.6
SEm±	0.14	0.11	0.09	0.14	-	-	1.06
CD (P=0.05)	0.43	0.34	0.26	0.42	-	-	3.16

*Square-root transformed and figures in parentheses are original values
DAP: Days after planting

5–27 days for stem planting during both years for a permissible yield loss of 5% (Fig. 1; Table 2). Critical weed-free period for root planting was more than stem planting by 6 days in Napier Bajra hybrid during both the years. Therefore, early weeding till 4 days after planting (DAP) or late weeding 32 DAP in root planting and 5 DAP and 27 DAP in stem planting did not prevent the negative effect of weeds in Napier Bajra hybrid. The results are in conformity with Shinggu *et al*. (2009), who found that critical period of weed interference in maize was 6 weeks after sowing and reported that the early period threshold, the period of weed competition that the crop can tolerate, appeared to be the first 2 weeks after sowing; whereas the late period threshold, the period beyond which additional weeding does not affect the yield, was found to begin 6 weeks after sowing.

Relation between green fodder yield and weed biomass

The prevalent weed species at the experimental site were *Eleusine indica, Acrachne racemosa, Dactyloctenium aegyptium, Chenopodium album, Amaranthus viridis* and *Cyprus rotundus*. The higher green fodder yield was obtained from crop planted with rooted slips during both years due to lower weed biomass as compared to planting from stem cuttings, and it was applicable for all categories of weeds. Stem cuttings supported the production of higher weed biomass as compared to root slips, thus, directly affecting the green fodder yield. Weedy check recorded significantly higher biomass of grassy weeds 60 DAP than rest of the treatments during both the years and was at par with treatment kept weed-free up to 10 DAP and weedy thereafter (Table 1). The biomass of grassy weed was significantly lower in plots kept weed-free up to 40 DAP over plots kept weed-free up to 30 DAP. Similar trend was observed in case of broad-leaf weeds as well as sedges. There was negative linear relationship between the green fodder yield of rooted slips and stem cuttings and weed biomass of all

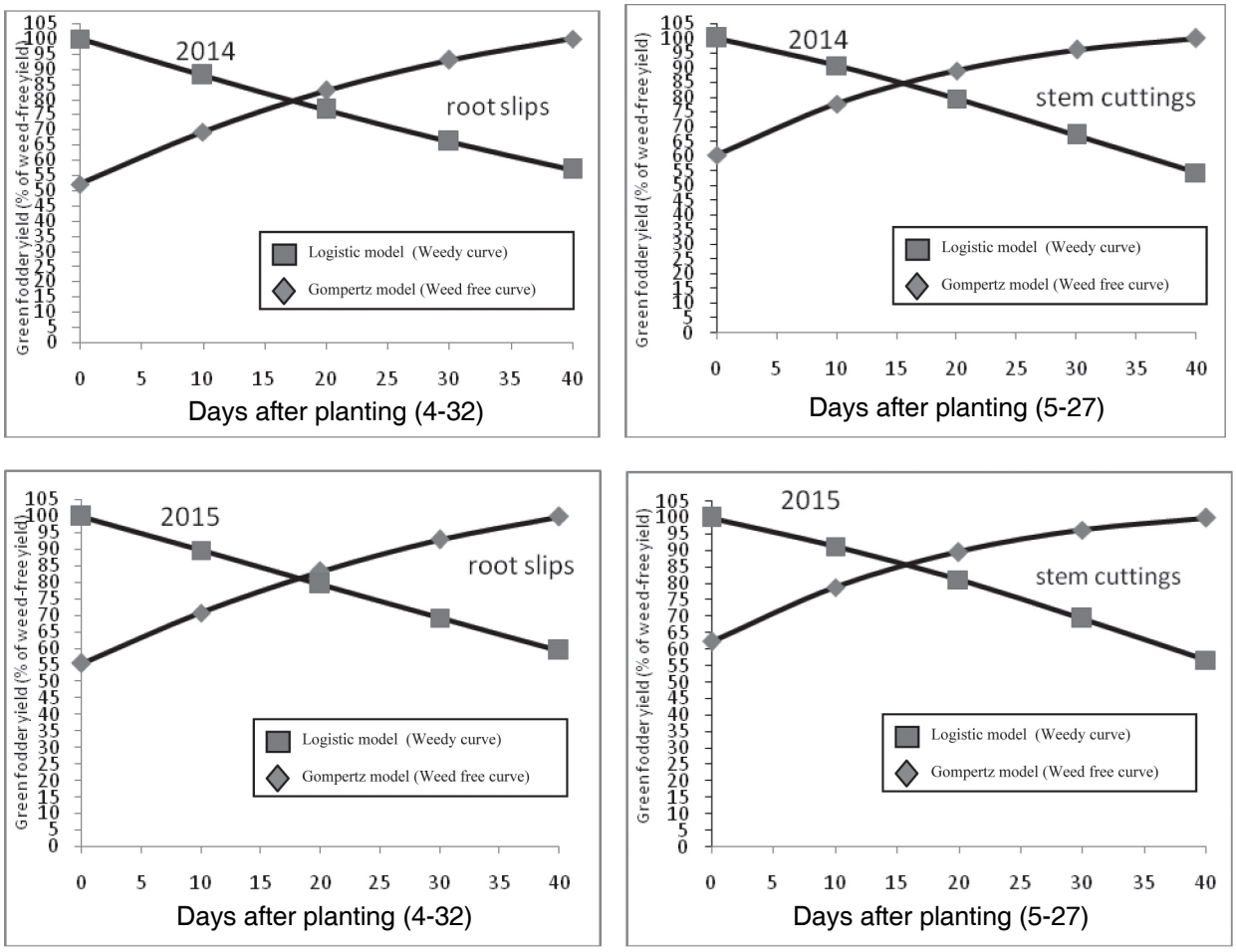

Fig. 1. Effect of planting materials and weed infestation durations on Napier Bajra hybrid green fodder yield (values for weed-free yield and weedy yield up to harvest were included in both curves for each planting method) in 2014 and 2015. Gomertz and logistic equations were fitted to green fodder yield (% of weed-free yield) in both years and parameter estimates of the equations are shown in Table 2

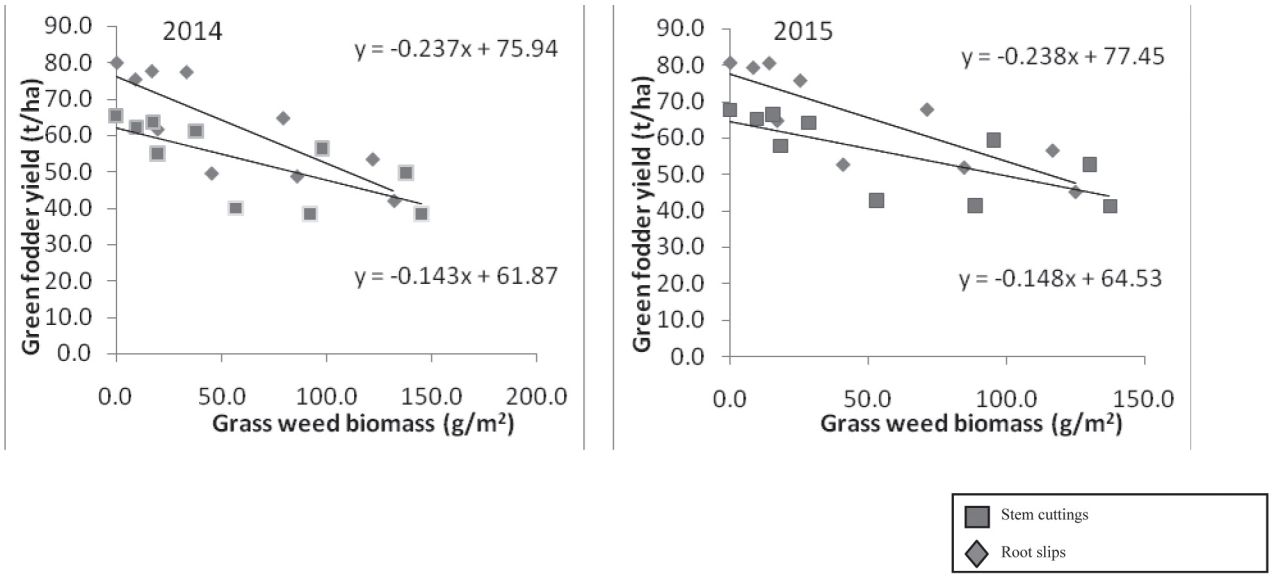

Fig. 2. Relationship between green fodder yield (t/ha) of two planting materials and grass weed biomass (g/m^2) in 2014 and 2015

weed categories in Napier Bajra hybrid (Fig. 2,3,4). It was reported that with each increment increase in weed biomass in both planting materials, there was reduction in yield during early growth period of crop.

Thus, it was observed that the critical period of weed competition in Napier Bajra hybrid should be adopted up to initial growing period, i.e. 10–30 DAP. To avoid the yield loss of crop, the weed-control measures should be taken at this critical period to avoid the yield loss of crop and minimizing the weed pressure.

Table 2. Parameters of Gompertz and logistic equations fitted to green fodder yield (% of weed-free yield) in 2014 and 2015

Planting material	2014			2015		
	a	*b*	T_0	*a*	*b*	T_0
Gompertz equation (fitted for increasing period of weed control)[a]						
Root slip	0.0451	0.7839	90.4275	0.0408	0.7348	93.3744
Stem cut	0.0615	0.5489	66.6252	0.0607	0.5190	69.6966
Logistic equation (fitted for increasing period of weed competition)[b]						
Root slip	–0.0199	1.7110	220.9	–0.0250	0.6719	138.4
Stem cut	–0.0407	0.2588	83.8786	–0.0403	0.2356	85.4656

[a]Gompertz equation: *a* is the asymptote, *b* is the exponential rate, and T_0 is the inflexion point

[b]Logistic equation: *a* is the lower asymptote, *b* is the measure of the rate of reduction in yield and T_0 is the weedy duration when a reduction in half of the maximum yield above '*a*' would occur

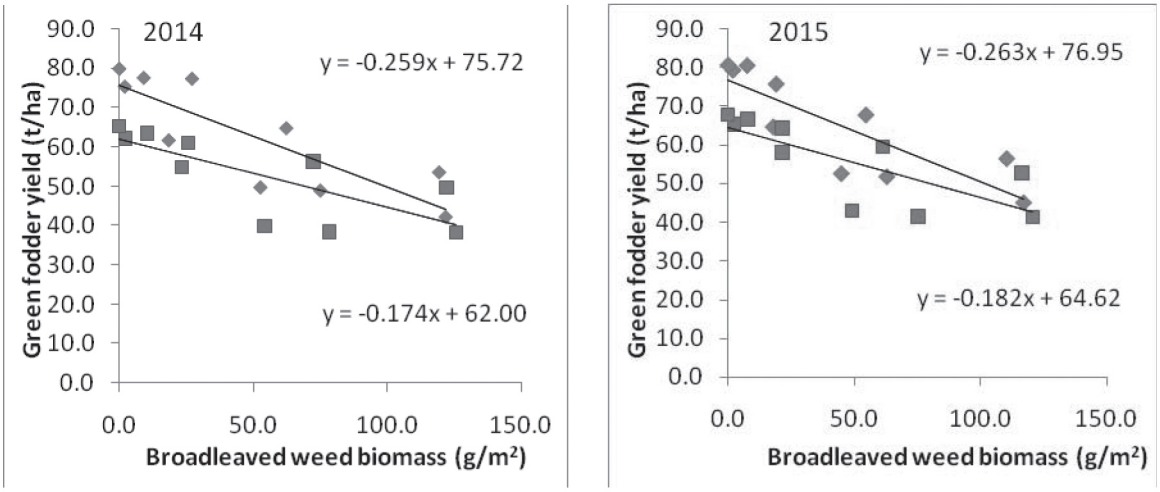

Fig. 3. Relationship between green fodder yield (t/ha) of two planting materials and broadleaf weed biomass (g/m^2) in 2014 and 2015.

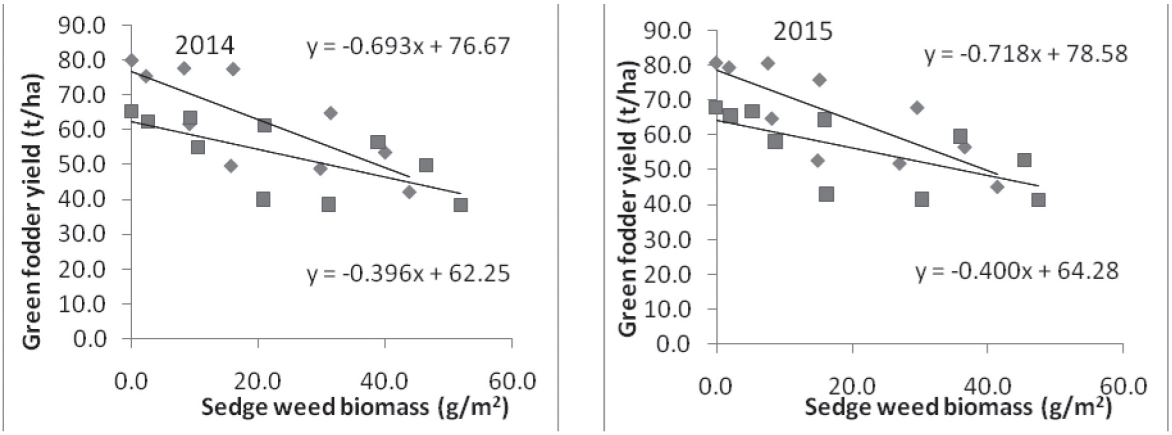

Fig. 4. Relationship between green fodder yield (t/ha) of two planting materials and sedge biomass (g/m^2) in 2014 and 2015

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