Quality Seed Production of Range Grasses--A Major Constraint in Revitalising Tropical Pastures

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Introduction

Only 4% of India's geographical area of 326.82 M ha is under pastures. Socioeconomic and ecological consequences of land degradation are affecting 85 M ha of rangelands/grasslands. To provide sufficient milk for the ever-growing population, current milk production of 128 M t must increase to 160 M t by 2020. To make this possible, an additional 825 M t of green fodder is required. Increasing the area producing green fodder is difficult because of severe competition from food crops. Revitalising the denuded grasslands is the most plausible means for improving the availability of green fodder. This needs mission mode programs with participation of the people.

One impediment to increased green fodder production is limited availability of good quality seed. In India only 25-30% of the required seed is available for sowing cultivated fodder and 20% and 15% for range grasses and legumes, respectively (Anon. 2011). Forage seed production encounters several problems, namely: poor seed setting; extreme climatic conditions; seed shattering and non-synchronisation in maturity; and the presence of empty seeds. Empty seeds with partially developed embryos and poor nutrient reserves fail to germinate. The standard germination percentage of most tropical grasses is around 20-30 percent. Several studies have been conducted to enhance germination by treating with GA_3 or KNO_3 or by other means of dormancy removal. However, the major reason for the low germination percentage is formation of 'false' seeds (dry floral parts without fully developed seeds). Wobus and Weber (1999) emphasised the role of hormones in combination with other seed metabolites, including sugar, in seed maturation. Understanding reproductive biology and harvest scheduling are also important for enhancing formation of pure, germinating seeds. Hence, the present study was conducted to understand seed setting and the effects of external hormonal application on seed germination.

Methods

Seed-setting studies

To study seed setting, the annual range grass, *Pennisetum pedicellatum*, commonly known as *Dinanath* grass in India, was chosen. The seed harvested in bulk was examined for the presence of caryopses in the spikelets by manual defluffing. Separately, 10 individual inflorescences of *P. pedicellatum* var. Bundel Dinanath-1 and Bundel Dinanath-2 were taken and caryopses from each spikelet were separated manually by slightly pressing at the bottom. The presence or absence of caryopses in spikelets was noted for further calculation. The seed-setting percentage was calculated by counting the total number of spikelets per panicle and spikelets carrying a true caryopsis.

Hormonal studies on seed germination

The effects of hormones on seed germination were studied by spraying 25, 50 and 100 ppm IAA (indolacetic acid) on *Panicum maximum* inflorescences in the field. The IAA solutions were prepared and 0.05% tween-80 was added to enhance adsorption of the solutions. Ten inflorescences were selected and the spray was applied twice at 4-day intervals. The individual treated inflorescences were collected along with controls at maturity and the seed was bulked for further germination studies, with 3 replications using the standard procedure in sand. Germination was recorded till no further increase in the number of seedlings was observed.

Seed-ripening studies

The effects of hormonal solutions on seed ripening were studied by dipping the cut panicles of *Panicum maximum* in hormonal solutions and water. Five guinea grass panicles were collected at the anthesis stage from the field. The panicles were dipped in 100 ppm and 200 ppm solutions of IAA, kinetin and water. A control without water was also studied. Matured seeds from each treatment were collected separately. The experiment was conducted under ambient room temperature with 3 replications.

Results and Discussion

The 2 released *Dinanath* grass varieties BD-1 and BD-2 were distinctly marked for single floret and 3 florets per sessile spikelet, respectively. The percentage of well developed seeds per panicle was found to be 96% and 92% in BD-1 and BD-2, respectively, whereas in normal bulk-harvested seed lots, only 20-60 % of spikelets contain filled seeds. The naked seeds, *i.e.*, caryopses, obtained showed 93% germination. Thus, formation of

Table 1. Effects of indolacetic acid (IAA) treatment of Guinea grass panicles on seed germination.

Treatments	Germination (%)		
	Day 4	Day 6	Day 8
Control	15.3	23.3	26.0
IAA 25 ppm	19.3	33.3	34.7
IAA 50 ppm	20.0	34.0	38.7
IAA 100 ppm	23.3	40.7	44.7

pure germinating seed (caryopses) in *Dinanath* was found to be >90%. Observations revealed that a lot of caryopses were dropped during harvesting in bulk harvests due to the floral structure of the species. Thus, harvesting at physiological maturity is crucial to optimise recovery of spikelets with caryopses. In this context, the development of physiological and harvesting maturity indices for bulk harvesting of *Dinanath* grass should be given high priority in research programs.

External application of IAA at 25, 50 and 100 ppm at the panicle emergence stage in *Panicum maximum* (var. BG-2) substantially increased germination, with the highest germination (45%) being obtained at 100 ppm IAA (Table 1). Rate of germination in IAA treatments was also higher than in the control. These results might be due to an increased number of pure germinating seeds or an increase in germination *per se*. Barazesh and McSteen (2008) showed that hormones play an important role in inflorescence development in grasses. A positive response of guinea grass to auxin (IAA) paves the way for further exploration of phytohormone-induced seed development in range grasses.

The cut panicles of *Panicum maximum* showed varied degrees of liveliness after treatment with different solutions. Cut panicles without water dried early, followed by those dipped in kinetin and water, with panicles dipped in IAA solution remaining viable for longest. In *P. maximum* under field conditions, spikelets shattered within a week after anthesis. If liveliness can be maintained in cut panicles, the shattering loss can be minimised and more mature seed can be collected than with bulk harvest.

Conclusions

Seed setting as such is not a problem in the annual range grass *Pennisetum pedicellatum* but shattering of caryopses during bulk harvest leads to a low germination percentage in harvested seed. Physiological and harvesting maturity indices must be developed to retain caryopses in the harvested spikelets. External application of phytohormone IAA at 100 ppm during anthesis could be one strategy for increasing subsequent seed germination. Additionally, in order to decrease harvesting costs in grasses with non-synchronous maturity, increased liveliness following IAA treatment could be a mechanism for optimising yield of high quality seed by allowing more time for seed maturity after harvest.

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