Effect of Spikelet Thinning on Individual Seed Weight and Seed Yield of Wheat Under Two Sowing Dates

S.K Roy[1,2] and A.B.M. Salahuddin[1]

ABSTRACT

Wheat was sown in miniplots on two sowing dates (19 November or 19 December) in two seasons to study the effect on seed yield and components of yield. Apparent translocation of pre–anthesis stem reserves to the developing seeds was followed by removing five spikelets from the top, bottom or middle of the ear, or from both top and bottom positions of the ear at anthesis. The objective of the study was to develop alternate management practices to enhance floret fertility and improve seed quality by increasing thousand seed weight (TSW) without significantly decreasing seed yield. In both seasons sowing date did not affect seed yield or its components with the exception of TSW which was significantly lower in the December sowing. Spikelet thinning from the top, bottom, middle or both top and bottom positions of the ear caused an 18, 22, 24 and 42% reduction in the number of seeds per ear, a corresponding increase of 12, 1, 0 and 14% in TSW but a consequent reduction in seed yield of 9, 15, 22 and 33% respectively. The number of seeds with TSW > 35g per spikelet was increased by 6–12% following spikelet thinning and seeds of mid–spikelets were generally heavier than those of the terminal or basal spikelets. Harvest index and apparent translocation of pre–anthesis stem reserves to developing seeds were decreased by spikelet thinning in both seasons.

***Additional index words*: apparent translocation, seed weight, seed yield, wheat, harvest index, yield components.**

INTRODUCTION

Heavy individual seed weight is an important quality characteristic of wheat intended for multiplication. However, the wheat cropping season in tropical regions is very short, and seeds tend to be very light. High temperatures and low rainfall result in the leaves and culms drying up rapidly and therefore it is difficult to achieve heavy individual seed weight. Deleterious effects of high temperature on wheat seed yield and quality are well documented elsewhere (e.g. Rawson, 1988; Saini and Nanda, 1986; Wardlaw, Dawson, Munibi and Fewester, 1989). High temperatures induce accelerated floral initiation (Wardlaw *et al.*, 1989) but assimilate supply to the developing florets remains insufficient, leading to poor grain set per spikelet (Kadkol and Halloran, 1988) and reduced individual seed weight (Rawson, 1988). Thinning of spikelets (Fischer, 1979) or chemical degeneration of terminal spikelets (Kadkol and Halloran, 1988) is reported to reduce competition for assimilates between individual florets and developing seeds, and may lead to increased floret fertility and increased individual seed weight under late–sown conditions. Methods to enhance floret fertility and seed weight have not been adequately quantified under tropical Bangladesh conditions. A preliminary study has shown that under dry conditions during grain filling, steady seed growth continued due to remobilization of pre–anthesis stem reserves (Roy, Maniruzzaman and Saifuzzaman, 1990). However, this can be modified by physical (Wardlaw, 1967) or chemical (Blum, Poiarkova, Golan and Mayers, 1983) treatment of the crop.

The objective of the present study was to achieve increased seed number per spikelet and increased individual seed weight under two sowing dates in the dry and warm Bangladesh environment. In addition, seed yield, harvest index (HI) and apparent translocation of pre– anthesis stem reserves to the developing seed of wheat were studied.

MATERIALS AND METHODS

The experiment was conducted in two consecutive years (1990–91 and 1991–92) at Joydepur (23.5ºN and 88ºE), Bangladesh. In general Bangladesh has a mild but dry winter with little rainfall from November to March. Day time temperature ranged from 25 to 30ºC and night temperature ranged from 12 to 20°C. Very dry conditions prevailed from late January to April as day length increased. The soil was a silt loam (Aeric Haplaquept) with pH 5.6. In both years the land was fallowed for three months following incorporation of the previous green manuring crop, Dhaincha (*Sesbania aculata* L.), into the soil. The experiment was laid out in a split–plot design where five spikelet thinning treatments were allocated to subplots with two sowing dates (19 November and 19 December) as main plots, with three replications. The land was fertilised with 100, 80, 40 and 20 kg ha^{-1} of N, P_2O_5, K_2O and S supplied from urea, triple super phosphate, muriate of potash and gypsum, respectively. Seeds of the photoperiod sensitive, high yielding spring wheat (*Triticum aestivum* L. cv Kanchan) were hand–sown at 120 kg ha^{-1} in 1.0 m x 1.0 m plots with a 200 mm row spacing. A post–sowing irrigation of 30 mm was given to ensure uniform emergence. One hand weeding at 25 days after sowing (DAS) and two irrigations of 25 mm each were applied at 40 and 70 DAS to raise the crop in both years.

Spikelets were thinned at the start of anthesis by manual removal of five spikelets either from the top, bottom and middle,

1 *Bangladesh Agricultural Research Institute, Joydebpur 1701, Bangladesh.*
2 *Present & corresponding address: Herbage Seed Section, AgResearch, P.O. Box 60, Lincoln, New Zealand.* *Accepted for publication 21 September 1994.*

or both top and bottom positions of an ear, keeping one unthinned control. Both main stem and tiller ears were included in the thinning operations and all plants from the middle two rows of the plots were thinned.

At anthesis (60 DAS) ten plants were sampled from each plot. Plant dry matter (excluding roots) was determined after drying at 75°C for 48 h in a hot air oven. When the plants approached maturity (indicated by rapid drying of ear, leaves and stem), dry matter and seed yields were determined on a further ten plants for the calculation of harvest index and apparent translocation of pre–anthesis stem reserves to developing seeds. Apparent translocation was calculated by a partial modification of the method of Gallagher, Biscoe and Hunter (1976) as follows:

$$\text{translocation (\%)} = ((\Delta GDM - \Delta TDM)/\Delta GDM) \times 100$$

where, ΔTDM and ΔGDM are the increases in total and grain dry matter, respectively, from anthesis to maturity with the assumption that assimilates of current photosynthesis were mostly used by the seeds, no vegetative growth occurred after anthesis, and leaf and stem part losses were negligible. Changes in weight of non grain plant components during grain filling were therefore due to translocation alone.

At maturity (10% seed moisture content) all plants from the middle two rows were harvested and hand threshed. Data for TSW, number of seeds per spikelet and seeds per ear were taken from ten randomly selected ears which were then divided into three sections i.e. the top, middle and bottom of each ear. No significant differences between years were found for any of the data recorded, and consequently the data were pooled for statistical analysis.

RESULTS AND DISCUSSION

Sowing date had no significant effect on seed yield, the number of ears m^{-2}, seeds per spikelet, seeds per ear or harvest index, and sowing date did not significantly interact with spikelet thinning for any of the above parameters (Table 1a). However, TSW from November–sown plants was significantly ($P<0.05$) greater than for December–sown plants. Heavier TSW from November–sown plants probably resulted from an increased duration of grain filling, and the completion of the life cycle before dry warm conditions prevailed. Apparent translocation was greater with the December sowing; this is consistent with Bangladesh growing conditions, as the late–sown crop is more prone to drought at seed filling, which results in premature drying of the crop. Wardlaw (1967) has previously noted the reliance of developing wheat seeds on pre–anthesis stored stem reserves when the crop was subjected to post–anthesis drought in Australia, and Blum, Poiarkova, Golan and Mayer (1983) desiccated the top of the wheat canopy as a simulator of post–anthesis drought in Israel and reported as much as 40% remobilization of stored pre–anthesis stem reserves.

Table 1. Effect of sowing date and spikelet thinning on wheat seed yield, yield components, harvest index and apparent stem reserve translocation

Treatment	Seed yield (g m^{-2})	Ears m^{-2}	Seeds $spikelet^{-1}$	Seeds ear^{-1}	TSW (g)	Harvest index	Apparent Translation (%)
a) Sowing date							
November 19	458	460	1.62	21.3	49.7	0.37	28
December 19	430	456	1.74	22.3	44.4	0.36	38
LSD P<0.05	NS	NS	NS	NS	1.88	NS	10.0
b) Spikelet thinning							
Nil	527	454	1.56	27.7	44.7	0.41	36
Top five	478	458	1.66	22.8	50.2	0.38	36
Bottom five	450	462	1.71	21.7	45.1	0.38	33
Midddle five	413	456	1.75	21.0	44.7	0.35	34
Top + bottom five	351	460	1.71	16.0	50.8	0.33	27
LSD P<0.05	99.4	NS	0.15	0.96	1.19	0.011	8.0
CV (%)	3.9	3.7	5.6	5.7	3.3	4.4	18.3

Seed yield was significantly affected by thinning of spikelets from the middle, or top and bottom positions (Table 1b). The severe reduction in the number of seeds per ear due to thinning and the failure of the increased number of seeds per spikelet to compensate sufficiently for the thinning loss explained most of the yield loss. Spikelet thinning had no significant effect on ears m^{-2}, but there was significant positive effect on seeds per spikelet caused by removal of the middle spikelets (Table 1b). Spikelet removal had a significant negative effect on the number of seeds per ear and this explained the reduced harvest index. (Table 1b). These trends agree well with those of Wardlaw *et al.* (1986) who reported increased seed set per spikelet due to changed growing conditions favouring increased assimilate supply per spikelet.

Increased TSW due to spikelet thinning, especially when spikelets were removed from the top and bottom positions of the ear (Table 1b) is likely to have resulted from increased assimilate supply to the individual seeds that remained after thinning, indicating scope for manipulation for better seed quality in wheat in tropical environments where seed quality is poor, provided a reduction in yield is acceptable. The results are consistent with those of Brindza (1986) and Rawson (1988) who reported increased individual seed weight with changes in post–anthesis growing conditions in the form of reduced spikelets per ear or reduced number of seeds per spikelet.

There was a significant effect of spikelet position in the ear on the number of seeds per spikelet and TSW (Table 2). Middle spikelets had more seeds per spikelet than the top or bottom ones. The seeds from the top spikelets were invariably smaller and those from the middle or bottom positions were larger irrespective of thinning treatments (Table 2). This could be due to the fact that seed set in wheat starts first in the middle of the ear and then moves acropetally, giving seeds in the middle spikelets a longer time for development. The florets of the middle and lower spikelets are also considered to have a better vascular connection with the main axis (Hanif and Langer 1972). Kadkol and Halloran (1988) and Sibony and Pinthus (1988) also reported increased seed set and seed weight of middle spikelets of a wheat ear.

Table 2. Effect of spikelet position in the ear on seeds per spikelet and thousand seed weight (TSW) of wheat

Spikelet position	Seeds spikelet^{-1}	TSW (g)
Top five	1.50	45.20
Middle five	1.83	49.00
Bottom five	1.71	47.04
LSD P<0.05	0.21	2.01

CONCLUSIONS

The results indicate that it is possible to increase the number of seeds per spikelet and seed size through November sowing and spikelet thinning. The removal of the top five spikelets reduced the number of seeds per ear but improved seed quality in the form of increased TSW without a significant seed yield reduction. However a practical and economic method of removing terminal spikelets would need to be found. The late–sown crop tended to have reduced individual seed weight. It is postulated that remobilization of pre–anthesis reserves to fill the developing seeds occurred, indicating little scope for manipulation for improved seed quality, but this has yet to be substantiated. Early planting is therefore recommended for increased seed yield and quality in warm and dry tropical conditions.

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