The colonization of different wheat parts by *Fusarium* species were investigated to establish whether vegetative wheat parts play a role in *Fusarium* spread from the ground to wheat ears. Field monitoring in Nakuru district, Kenya showed that FHB in wheat was the result of a complex of 19 *Fusarium* species. However, 80% of all *Fusarium* infections on leaves, stems and ears were attributed to *F. chlamydosporum*, *F. boothi*, *F. poae*, *F. scirpi, F. arthrosporioides*, *F. oxysporum* and *F. graminearum*. Using LC/MS/MS, eleven *Fusarium*-related mycotoxins were detected in kernels sampled at harvest. DON was the most prevalent mycotoxin. To investigate the susceptibility of different wheat parts under controlled conditions, above-ground parts of wheat were inoculated with *F. avenaceum*, *F. culmorum*, *F. graminearum*, *F. poae* and *F. tricinctum*, respectively at mid-anthesis. Colonization of different parts in decreasing order was: spikelets, kernels, stems, and leaves. Inoculation of *Fusarium* species resistant cv. Petrus and susceptible cv. Ritmo at GS 65 resulted in significantly higher FHB and infection of spikelets, kernels and stems than when inoculated at GS 47. Quantification of *Fusarium* species-specific DNA using real-time PCR showed the highest DNA content in stems followed by leaves and lowest in kernels. Concentration of mycotoxins in plant parts sampled at harvest was highest in stems and lowest in kernels. *F. culmorum* resulted in the highest fungal biomass and major mycotoxins concentration followed by *F. graminearum*, *F. avenaceum*, *F. tricinctum* and *F. poae*, respectively. When kernels, stems and leaves were inoculated *in vitro,* ergosterol content – quantified by HPLC - was highest in kernels and lowest in stems while *Fusarium*-species specific DNA content was highest and lowest in kernels and leaves, respectively. During conidia germination and germ tube growth, interactions between *Fusarium* isolates were predominantly competitive with the macroconidia-producing species being more competitive. Conidia germinated with more than one germ tube per conidium cell and germ tubes grew on the host surface forming a mycelial network. In leaf tissues, hyphae grew both inter- and intra-cellular. Fungal structures were detected only in and around lesions. Incubation of senescing leaves at 100% relative humidity for 48 hours resulted in sporulation of the five *Fusarium* species. Infection of vegetative wheat parts by *Fusarium* spp. make a contribution to ear infection and pose a health risk through production of mycotoxins to animals which consume straw.